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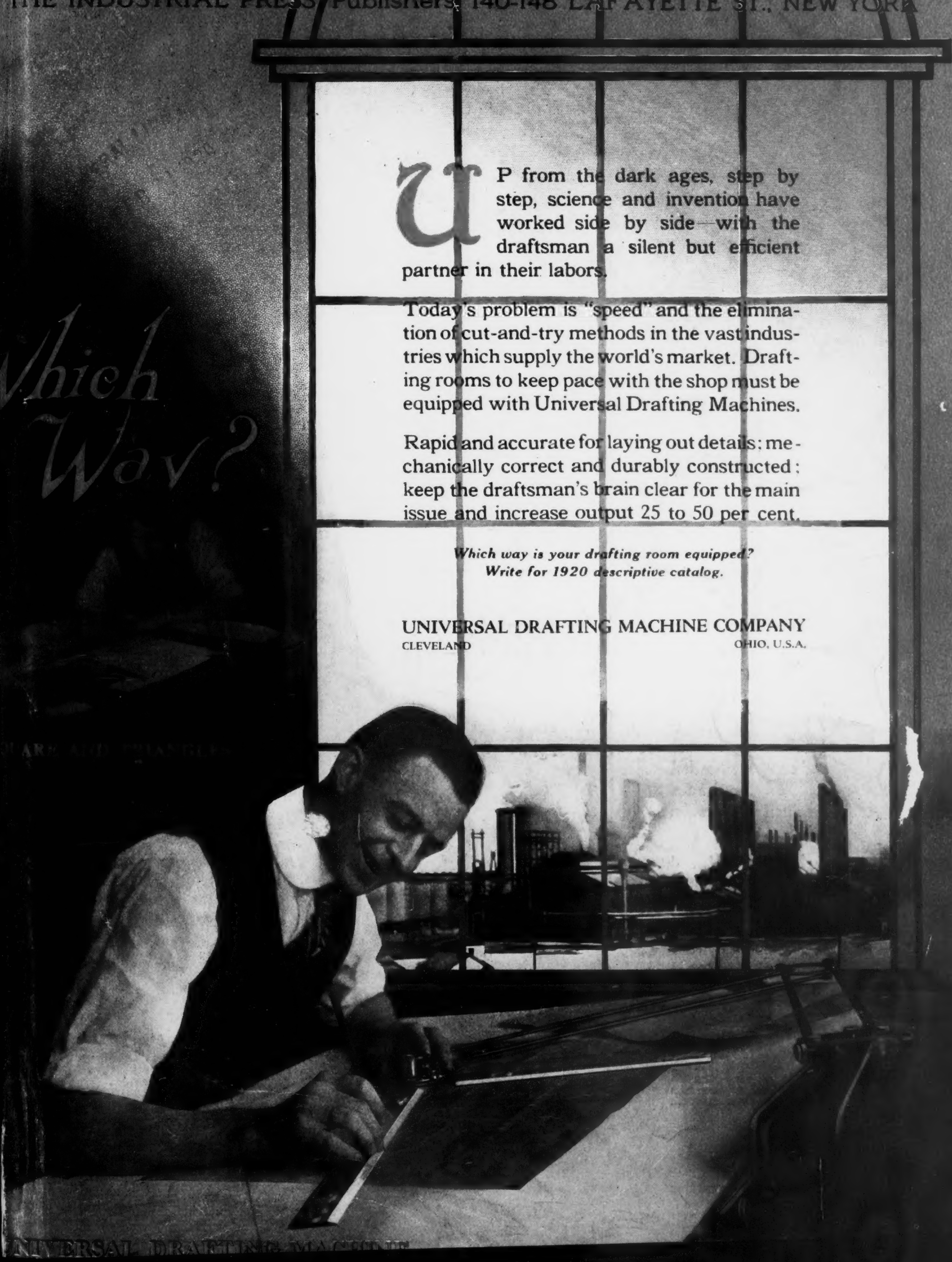

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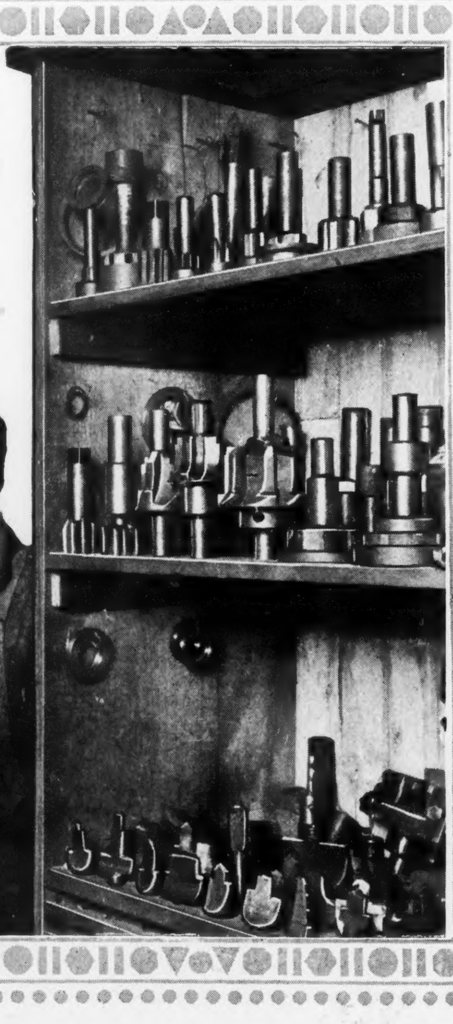

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Making Seamless Copper and Brass Tubing

A Detailed Description of the Methods Employed and the Equipment Required in the Production of Seamless Copper and Brass Tubes

By EDWARD K. HAMMOND

SEAMLESS copper and brass tubing is used in the construction of various types of surface con densers as well as for a great many other purposes. While the war demand for manufactured products was at it height, the Wheeler Condenser & Engineering Co., of Carteret, N. J., experienced trouble in obtaining prompt deliveries on tubing required for use in the construction of condensers. This difficulty finally became so acute that a decision was reached to install a casting shop and tube mill at the company's plant, so that tubing could be made at the factory instead of depending upon an outside source of supply. This department of the business was placed in operation a little over three years ago and proved successful from its very beginning. At present all of the tubing used in building Wheeler condensers is made at the plant, and in addition the mill is turning out a substantial surplus which is being sold for general consumption under the trade name of "Crescent" brand.

Materials Used in Making Seamless Tubing

There are a number of different metal mixtures used by the Wheeler Condenser & Engineering Co. for making seamless copper and brass tubing, among which three typical formulas are as follows: (1) Pure copper. (2) Copper, 60 per cent; and zinc, 40 per cent. This mixture produces an alloy known as "Muntz" metal. (3) Copper, 70 per cent; zinc, 29 per cent; and tin, 1 per cent. This produces a brass known as "admiralty" mixture.

The method of procedure in making seamless tubing varies according to the metal of which the tubing is made, but in any case the process is started in the brass foundry, where the required constituents of the various alloys are mixed together. The metal is then melted and cast into billets ready for delivery to the tube mill. At the Wheeler plant two types of melting furnaces are used, one of which is the familiar pit type of crucible furnace equipped with natural draft and using coal for fuel. The other is an oscillating type of electric furnace built by the Detroit Electric Furnace Co. of Detroit, Mich. Installation of the electric furnace is a recent development at this factory, but the prediction is made by those responsible for the work of the casting shop that eventually all of the metal will be melted by heat generated by electric current. In making up a charge of metal ready to be melted and cast into billets for the tube mill, there is just as definite a relationship between the percentage of copper, zinc, tin, and other constituents, as that which exists in a doctor's prescription as it is made up by a druggist. Where the metal is to be melted in a crucible furnace, a separate charge is made up for each furnace and placed in a tote box in which it is delivered to the furnace.

Solid Billets and Cast Shells

There is a difference of practice in casting the metal from which seamless tubes are to be made, according to its composition. Some billets are cast solid, with a small socket at one end, while others are cast with a cored axial hole extending all of the way through the billet. All alloys crystallizing in a form known as the alpha (α) structure are worked with the metal cold, whereas Muntz metal containing 60 per cent copper and 40 per cent zinc is first cast in billets and then heated before being pierced, because it is composed of a mixture of alpha (α) and beta (β) crystals. The beta crystals give to an alloy in which they occur the property of being ductile at a higher temperature. It is necessary, however, to form these billets with a shallow recess or socket at one end, so that this socket may be made the starting point in piercing the billet.

Construction and Use of the Billet Mold

Regardless of whether the billets are cast solid or in the form of cylindrical shells, the molds used for this purpose are of essentially the same form. These molds are made of a grade of gray cast iron which is high in graphitic carbon.

Fig. 1. Tube Mill of Wheeler Condenser & Engineering Co.

Each mold is supported by two trunnion bearings, with a latch at the lower end of the mold, to hold it in a vertical position until the metal has been given time to solidify. The mold is then swung into a horizontal position to enable the billet or shell to be removed. It might appear that the cast-iron molds used for this purpose would not be particularly durable, but this is not actually the case. In a shop where forty or fifty heats are poured every day, these cast-iron molds can frequently be used for as long a period of time as nine months before it is necessary for them to be replaced.

After the metal has been cast and given time to solidify, the latch at the bottom of each mold is released and the mold is tilted into a horizontal position. Then a pin, which projects crosswise through the bottom of the mold, is withdrawn so that an iron plug which closes the bottom of the mold is no longer held in place by this cross-pin. The workmen now are able to take iron bars and push the billets out of the molds, as shown in Fig. 2, after which the molds are thoroughly cleaned with a wire brush and swabbed with a mixture of oil and graphite before they are ready for subsequent use. The plug which enters the bottom of each billet mold has a pilot on its upper end, which forms a socket in the end of the billet.

After the billets have been removed from the molds, the molds are cleaned by first using a wire brush to remove all oxide scale and other foreign matter; and then the inside of each mold is swabbed with a cotton waste swab saturated with a mixture of oil and powdered graphite. The purpose of this treatment is to cover the inside iron surface of the mold with a film of graphite which serves the double purpose of making the billet exceptionally smooth on the outside, and of protecting the inside iron mold from damage by the molten brass or copper.

For use in casting metal from the electric furnace, a special track has been constructed for passing the billet molds under the furnace. This track carries trucks on which the billet molds are supported, and a chain conveyor traverses the trucks and molds under the furnace. Adjacent to a controller which governs the tilting of the electric furnace to pour the molten metal, there is a controller that governs the movement of the molds under the furnace. This makes an ideal manufacturing equipment, as practically no manual labor is required in casting the metal, while with the old crucible type of furnace, the removal of the crucibles and pouring of the metal is an exceedingly laborious job even under the most favorable conditions.

Recovery of Scrap Brass and Copper

With copper selling at approximately twenty cents a pound, and other constituents of the alloys used in making seamless tubing commanding proportionately high figures, it is of unusual importance for the greatest care to be taken in recovering as much scrap metal as possible. In the tube mill, there are a number of obvious sources from which scrap metal can be collected. For instance, many tubes are sold

Fig. 2. Molds for Solid Billets in the Brass Foundry

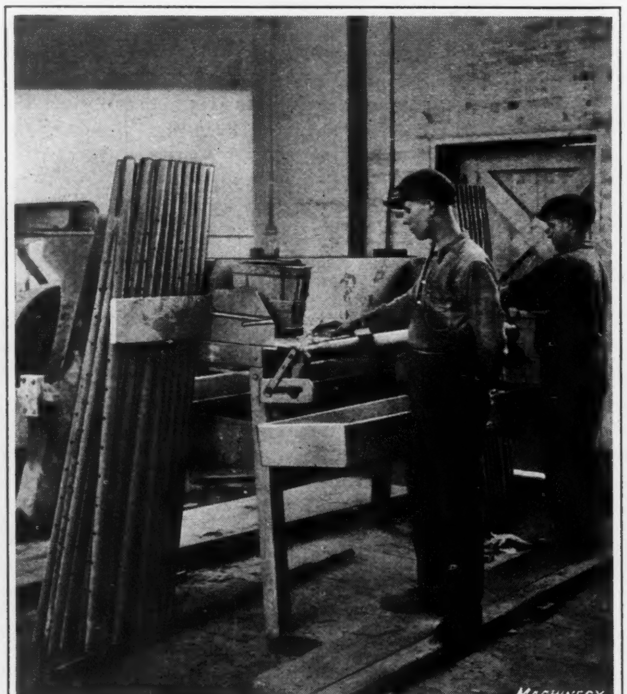


Fig. 3. Making Cores for casting Hollow Brass Shells

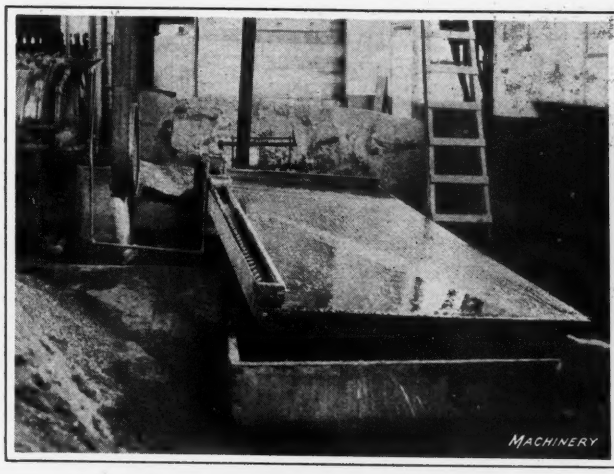


Fig. 4. Oscillating Table over which Foundry Refuse is passed to recover Particles of Brass and Copper

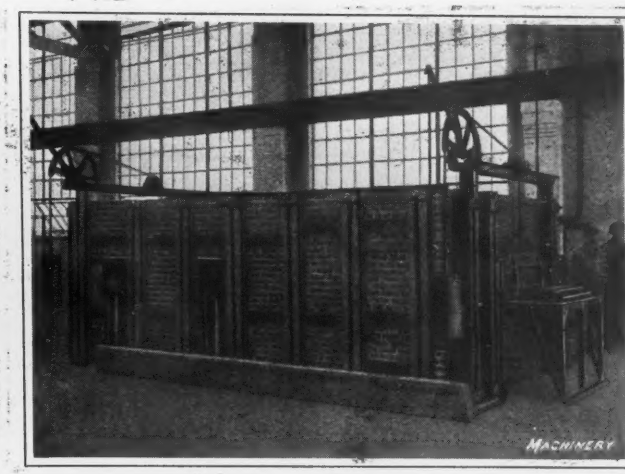


Fig. 5. Rockwell Furnace in which Copper and Brass Billets are heated preparatory to piercing the Hole

on orders calling for specified lengths; and after being drawn, such tubes are cut to length, with the result that pieces known as "crop ends" are left, which are too short to be used. Such pieces of tubing are collected and sent back to the casting shop in order that they may be remelted. Another obvious source of scrap metal is created by the necessity of pointing the end of a pierced billet in order that it may be passed through the drawing die and grasped by the tongs on the draw-head. After the tube has been drawn down to the required size, this pointed end that has been grasped by the tongs must be cut off, and the scrap metal produced in this way is returned to the casting shop.

Examples of the collection of scrap metal which were mentioned in the preceding paragraph represent fairly self-evident methods of saving material; but there is another saving of a less obvious and far more interesting character. This is the recovery of all scrap metal from the furnace ashes in the casting shop. In lifting the crucibles of molten metal out of the furnace, it is inevitable that a certain amount of their contents will be spilled, both in the furnace and on the floor adjacent to the top of the pits. To prevent a serious item of loss resulting from this cause, a point is made of collecting both the furnace ashes and the dust which is swept up from the floor around the furnace. All of this material is first passed through a No. 3 Marcy mill. The barrel of this mill is filled with steel balls and water, and the barrel rotates continuously, so that the balls crush the larger pieces of ash and enable a separation of the metal and ash to be made during a subsequent step of the process. A stream of water is continually flowing through the Marcy mill, and as the contents of the barrel are crushed, the water washes the small pieces out through the openings to an oscillating separating table of the type shown in Fig. 4. The surface of this table is inclined in two directions so that the corner on which the contents of the mill are discharged is at the highest elevation.

Along the left-hand side of the table, as shown in the illustration, a continuous stream of water flows over the table while it is continually oscillating. The combined effect of the water and oscillation of the table is to effect a complete separation of all particles of metal from lighter materials such as coal, ash, etc., the lighter substances moving across to the right-hand side of the table, while the heavier metal moves lengthwise along the table and is collected in the trough at the front end. The illustration shows what appears to be a diagonal line of demarcation extending across the table from corner to corner. This represents metal particles at the left-hand side and coal and ash particles at the right. After passing over the oscillating table, the metal which is collected in the trough must be subjected to a further process of purification. This is made necessary by the fact that certain iron particles are present, which would impair the quality of the metal for use in making seamless non-ferrous tubing. To remove the particles of iron and steel which are present, the scrap metal is passed through a magnetic separator made by the Magnetic Separator Mfg. Co., of Milwaukee, Wis., and after being purified in this way, the metal is ready to be remelted and cast into billets for delivery to the tube mill.

Making Cores for Casting Hollow Shells

Mention has already been made of the fact that the hollow cylindrical shells, which represent the starting point of certain classes of brass tubing, are cast in the same form of molds that are used for producing solid billets. It will be evident, however, that a core must be provided in order to make the axial hole in the shell. The cores used for this purpose are made of sand, but in order to give them the necessary strength, the sand is molded on an iron pipe in which holes are pierced so that gas from the molten metal may pass through the core and readily escape from the mold.

In making the cores that are used for casting these shells, the method of procedure is as follows: A layer of hay is first wrapped around the iron pipe and the sand is then molded on top of this hay. For use in making cores of this type the sand is carefully ground to a uniform fineness on the grinding machine built by the International Clay

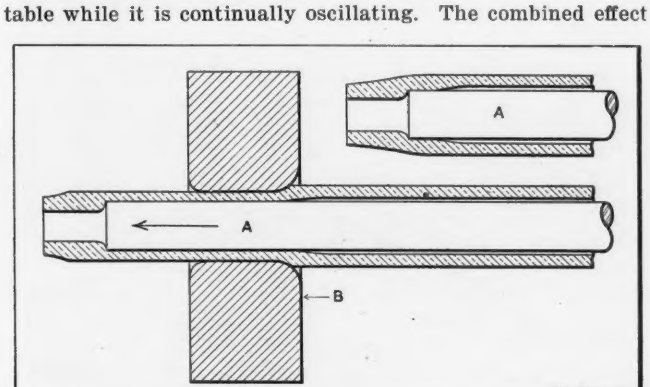


Fig. 6. Diagram illustrating Principle governing Operation of Extrusion Press shown in Fig. 8

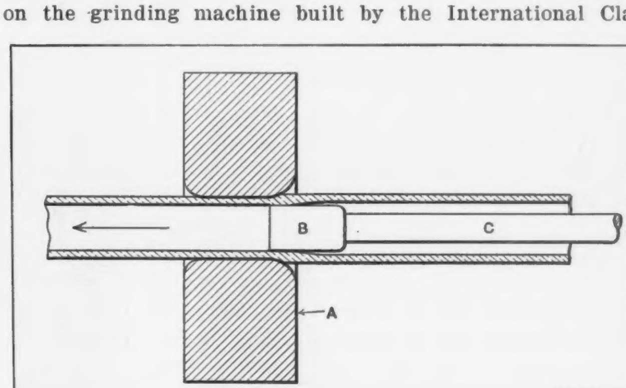


Fig. 7. Diagram illustrating Principle governing Operation of Equipment for drawing Seamless Tubing

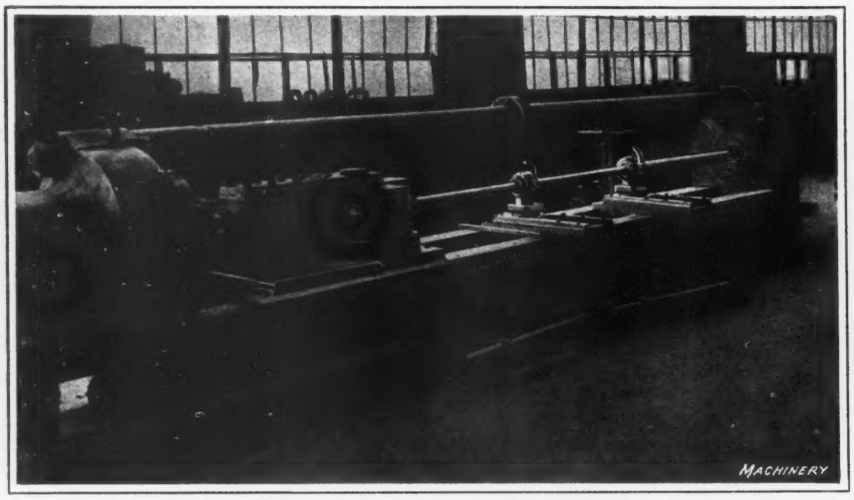


Fig. 8. Special Hydraulic Extrusion Press on which Large Billets are reduced to a Point where they can be handled on the Tube Drawing Benches

Machinery Co. of Dayton, Ohio. This sand is mixed with water to give it about the consistency of a batter, so that it may be readily spread over the hay-covered pipe by hand. The iron pipe is then placed on two special roller bearings as shown in Fig. 3, so that it may be rotated in contact with a straightedge, and in this way the surface of the sand is worked down to make the core perfectly straight. After it has been trued up in this way, the core is placed on a rack in a steam-heated oven, which thoroughly dries the sand. The final step in core-making is then to remove the cores from the oven and cover their surface with whiting which serves about the same purpose as the graphite which is applied to a sand mold in the foundry, namely, to give the cores a smooth surface so that they will produce shells with a uniformly smooth bore. It is absolutely important for the cores to be kept perfectly dry until they are used. Even the small amount of moisture which the core might absorb from the atmosphere would be detrimental. For that reason, the cores are stored in a room heated by braziers of burning charcoal.

Removing the Cores from Cast Shells

After the cast shells have been removed from the molds, it is necessary to get the cores out of the shells. A special horizontal hydraulic press is then used for this purpose, that has a cradle in which the shell is placed so that its end rests against a shoulder on the cradle. When the ram comes forward and strikes one end of the core, it is able to push the iron pipe out, because under pressure the core sand between the iron pipe and the shell is readily broken up. The shells are now thoroughly cleaned on the inside to remove all traces of core sand and other foreign matter. They then go to a special lathe, equipped with a rotary cutter-head, on which an operation known as "scalping" is performed. This consists of turning the outside of the shell in order to remove all scale and other foreign matter which might cause trouble in two ways, namely, through damaging the tube-drawing die or by causing seams or other surface defects to appear on the finished brass tubes. It is not necessary to perform such a scalping operation on the copper billets; but all brass shells and solid brass billets must be turned to remove the outer scale, before the tube-drawing operation is started.

Preparing Billets and Shells for Drawing them into Seamless Tubing

After certain preliminary operations have been performed, the method of drawing all classes of seamless copper and brass tubing is the same, except for the number of annealing treatments which the work receives and the amount of reduction in size which is possible for each passage of the work through the drawing dies. But there is a distinct difference in practice in so far as the preliminary operations on solid billets and hollow shells are concerned. Alloys which are cast in shells are made up of metal that forms alpha crystals at normal temperatures, and they become brittle when heated; whereas, the solid billets are composed of a metal mixture which contains both the alpha and beta crystallization forms, and they are ductile when heated and can, therefore, be worked hot. Alloys having the alpha crystallization, after being strained or worked and then annealed, will show on examination with a microscope that the crystals are polyhedral in form and entwined. In a worked brass alloy containing both the alpha and beta crystals, the alpha will show twining, whereas the beta will not show that characteristic.

Having made this preliminary explanatory statement of the reasons governing the variations of practice in handling different classes of work, we are ready to proceed with a detailed description of how the operations are performed. The cast cylindrical shell of the admiralty alloy must first be annealed in order to remove the copper-tin eutectic, known as the delta crystallization, which is deleterious to the working properties of metal. The annealing is done in an oil furnace built by the W. S. Rockwell Co., 50 Church St., New York City. The time required for annealing depends upon the alloy and the thickness of the metal. After they have been annealed, the shells go to a pointing machine which slightly reduces the diameter of one end, so that the point will enter the die on a hydraulic extrusion press, shown in Fig. 8, by means of which the shell is forced through the die that reduces its outside diameter and holds the inside diameter constant, so that the shell is gradually worked out into the form of a tube. As the shells are made of alpha metal, it will be evident that the extrusion operation is done cold.

The way in which this extrusion press operates is the exact reverse of the action of a draw-bench, and this will be best understood by referring to the diagram Fig. 6, which shows the arrangement of the different parts of the apparatus. Here it will be seen that plunger *A* is made of the same diameter as that to which the inside of the tube must be reduced by the extrusion operation. Plunger *A* is pushed through the inside of the shell until it abuts against the shoulder formed by the inside of the pointed end of the work, which has already been passed through the die *B*. Application of hydraulic pressure causes the plunger *A* to move in the direction of the arrow, and the result is that

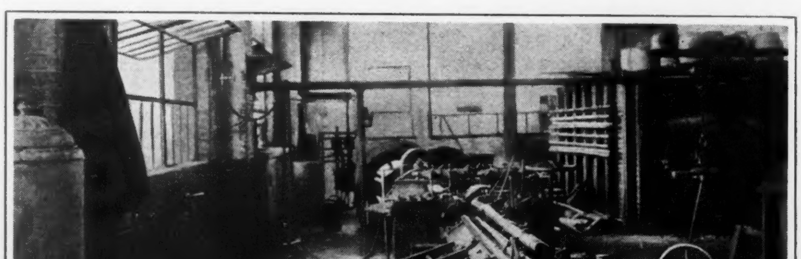


Fig. 9. Special Rotary Piercing Machine on which the Billets are pierced preparatory to the Tube Drawing Operations

it draws the shell through the die. Plunger *A* determines the inside diameter of the work, and die *B* determines the outside diameter, the tendency being for the metal to flow backward around the lip of the die to reduce the outside diameter and make a corresponding increase in the length of the work. It is considered necessary to perform three or four operations on the extrusion bench before starting to draw the work through dies mounted on the chain draw-benches. The work is annealed between each pass through the die.

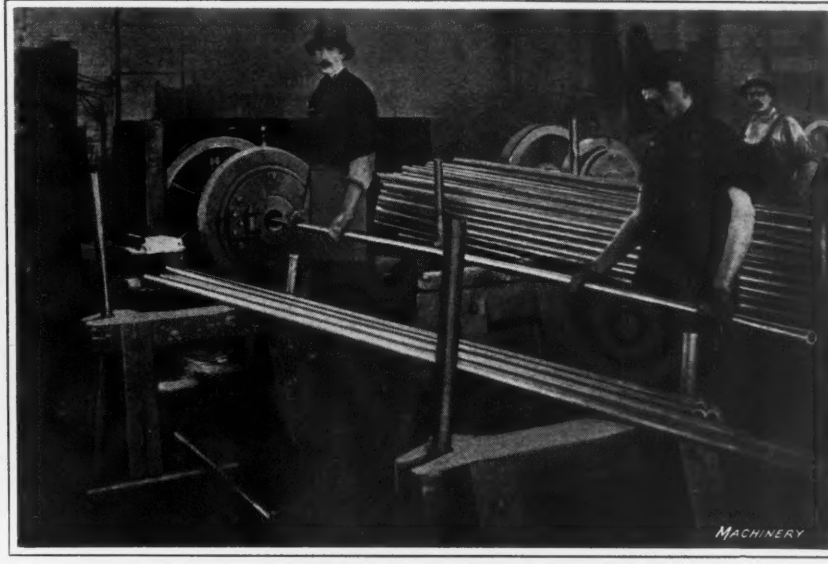


Fig. 10. Rotary Type of Pointing Machine on which One End of the Pierced Billet is reduced to a Diameter Small Enough to enable it to pass through the Tube Drawing Die

Piercing Solid Billets

In the case of copper and brass billets which are cast solid, a piercing operation is performed which represents the counterpart of the extrusion operation on hollow shells. There is, however, an important distinction; namely, that the solid billets are made from beta metal, so they can be pierced while at a cherry red heat. As they come from the casting shop, the billets are placed in a W. S. Rockwell oil-heated furnace, shown in Fig. 5, to have their temperature raised to the required degree, after which they go to a special rotary piercing machine shown in Fig. 9, which is equipped with two feed-rolls that force the work over a piercing mandrel. It will be recalled that an iron plug is placed in the bottom of each mold used in the casting shop for making solid billets, to form a cavity or socket approximately 2 inches deep in the bottom of the billet. This socket forms the starting point of the piercing operation, enabling the mandrel to center itself on the work. The two feed-rolls on the piercing machine have their axes inclined at a slight angle to each other. When the billet is placed between these rolls, which rotate in opposite directions the angularity of the rolls tends to impart a longitudinal movement to the work between them. In this way, the heated billet is fed against the end of the mandrel with sufficient force to cause it to pierce a hole right through the billet. The piercing mandrel is made of tool steel mounted on a machine-steel shank, and after the work has been pushed over the mandrel, a hydraulic cylinder connected to the rear end of the shank pulls the mandrel out of the work. The general arrangement of this equipment is in accordance with the Mannesman principle which was illustrated and described on page 326 of the December, 1918, number of MACHINERY, in connection with an article entitled "Making Electric Steel for Roller Bearings," dealing with the manufacture of seamless steel tubing.

Pointing Pierced Billets and Extruded Shells

An explanation has just been given of the way in which billets which are cast solid are pierced preparatory to performing subsequent operations on the draw-bench; and it will be recalled that in the case of cylindrical shells which are cast over a core, the preliminary steps in converting the shell into a drawn tube are performed on a hydraulic extrusion press. Regardless of whether the preliminary operations were performed on a piercing or an extruding machine, it is necessary to point the end of each piece of work before it is sent to the draw-bench. This pointing operation may be performed in either of two ways: On the larger sized billets and shells, it is found convenient to use a special form of power press which is equipped with an upper and lower die member in each of which several semi-cylindrical openings are cut. When the two halves of the die are together, each of the cylindrical openings so formed is slightly smaller than the next opening to the right of it. In pointing the tube, the operator first inserts it in the opening at the right-hand end of the die, and allows the press to reciprocate the top die member up and down while the tube is turned in the die. After getting a preliminary point in this manner, the operator moves the tube into a die-opening further to the left, and repeats the performance. By following this method, the tubes may be pointed with very little loss of time, and the surface of the reduced diameter is sufficiently smooth and uniform so that it will always pass through the die without giving any serious trouble.

For pointing smaller sizes of work, it is found advantageous to make use of a rotary swaging machine, Fig. 10, in place of the reciprocating pointer which has just been described. These rotary machines are of essentially standard design, being equipped with a swaging head which rotates at high speed and imparts a rapid succession of blows upon the end of the tubing that is introduced into the die, thus reducing the diameter.

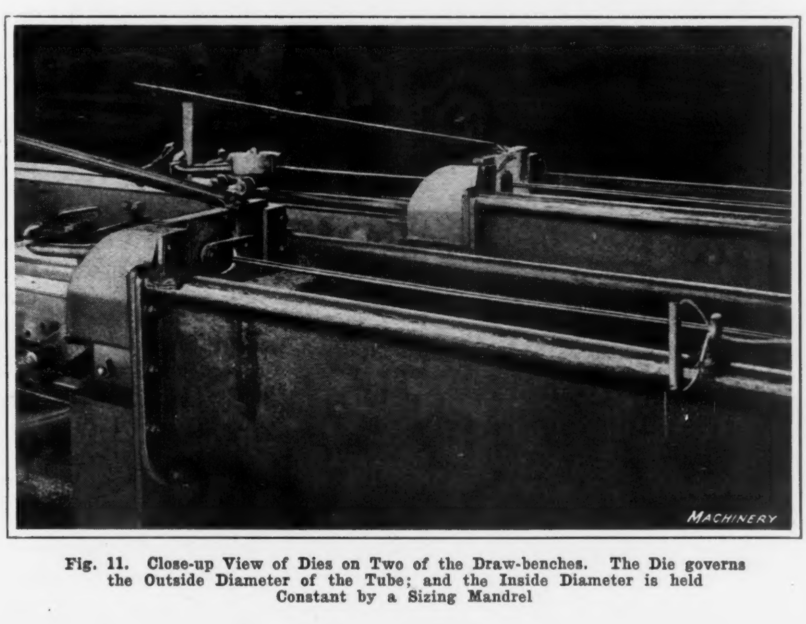


Fig. 11. Close-up View of Dies on Two of the Draw-benches. The Die governs the Outside Diameter of the Tube; and the Inside Diameter is held Constant by a Sizing Mandrel

Drawing the Tubes

Regardless of whether the metal is of the alpha structure which was cast in the form of a hollow shell or of the beta structure, cast as a solid billet, the practice in drawing tubing is the same. After the work leaves the extrusion press or the piercing machine, it is pointed and then subjected to successive cold-drawing operations on draw-bench equipments of the form shown in Fig. 11.

There is nothing special about the design of draw-benches used for producing seamless tubing, the construction being identical with

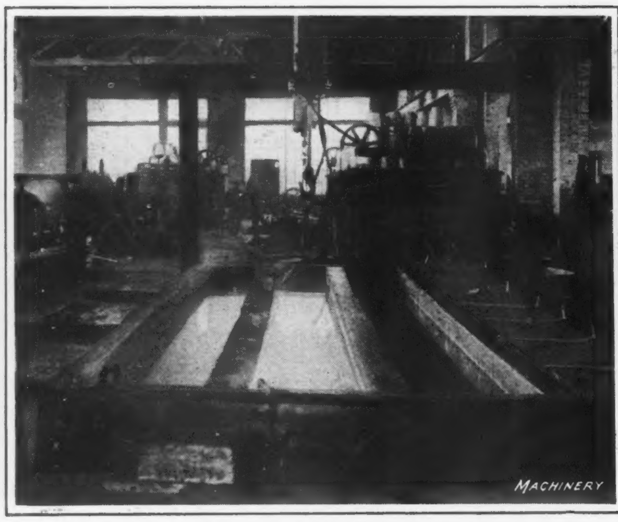


Fig. 12. Annealing Furnace and Pickling Baths. After annealing, the Hot Tubing is sprayed with Water and then dipped in the Pickling Baths to remove Scale

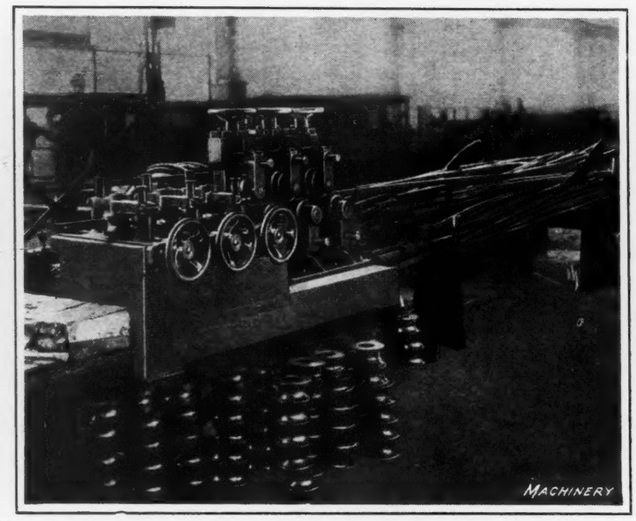


Fig. 13. Close-up View of One of the Straightening Machines through which the Tubing is passed to remove Irregularities in Shape after it has been drawn

that of equipments used for the production of cold-drawn shafting, etc. Such draw-benches have been fully illustrated and described in previous articles published in MACHINERY. The drawing die is also of standard design, but it is necessary to provide a mandrel for governing the inside diameter of the tube. By referring to the diagram shown in Fig. 7, the reader will obtain a good idea of the way in which the die *A* and mandrel *B* function in reducing the outside and inside diameters, respectively. In drawing a tube through the die, the action is exactly the same as if a solid bar were being reduced to a specified diameter; but the tool-steel mandrel is secured to the end of a machine-steel rod *C* anchored to the draw-bench in such a position that the mandrel is held immediately in front of the die, as shown in Fig. 7. This leaves an annular space between the die opening and the mandrel through which the tube passes, and in so doing the outside and inside diameters are reduced to the required sizes.

Annealing

The effect of the drawing operation upon the metal is similar to that which takes place in drawing steel or other products—namely, to impart a high finish to both the inside and outside surfaces of the tube, and to compress the metal, thus increasing its density. There is a tendency for copper and brass to become harder as a result of mechanical working, and to overcome this tendency, recourse is had to an annealing operation which is performed between each draw or each second or third draw, according to the nature of the metal and the tendency it shows to become hard and strained when passed through the die. Oil furnaces built by the W. S. Rockwell Co. are used for this purpose. A track runs right through each of the annealing furnaces, and trucks are provided that run on this track. A number of these trucks are loaded with tubing to be annealed, and coupled together so that they may be drawn through the furnace in a continuous train. Each truck remains in the furnace just long enough to anneal the tubing carried on it. Fig. 12 illustrates the general arrangement of the equipment used for this purpose.

Fig. 14. General View in the Tinning Department where a Protective Coating of Tin is applied to the Inside and Outside of Copper or Brass Tubing

Pickling

After annealing, the tubes are cooled by spraying water on them with a hose. They are then dipped into a pickling tank containing a solution of "Edis" compound which is an acid sodium sulphate that is a by-product in the manufacture of nitric acid. The pickling bath is of such strength that it has a specific gravity of 30 degrees Baumé. When it has been pickled, the work is washed by dipping it into a tank of clear water, after which it is allowed to dry and is then ready to receive the next draw. The amount of reduction which can be made in the thickness of the wall of the tubing for each pass through the die varies according to the nature of the metal and the size of the tubing.

Straightening

While being annealed, the tube shows a tendency to become quite badly distorted, and after each annealing process, it must be passed through a straightening machine before the next drawing operation is performed. The need of this straightening will be evident when it is recollected that the sizing mandrel must be pushed through the work, as a great deal of time would be lost in attempting to push the mandrel through a distorted tube. One of the straightening machines used to bring the tubes back into condition for the next operation is shown in operation in Fig. 13, from which it will be seen that the design is the same as the familiar form of staggered roll straightener that is used in wire mills, except that it is of much larger size. The straightened tubes are then thoroughly cleaned, cut up into specified lengths, and subjected to a water pressure test to make sure that there are no leaks in the tubes or flaws which are likely to develop into leaks. Every tube then receives a thorough visual inspection, as shown in Fig. 15, and samples are subjected to bending and flattening tests. The tubing which successfully passes all of these inspections and tests is packed in wooden boxes for shipment to the user.

Making Tinned Seamless Tubing

For certain classes of work, some engineers specify seamless copper or brass tubing which has been

Fig. 15. General View of the Inspection Department where all Defective Tubing is rejected before the Product goes to the Shipping Department

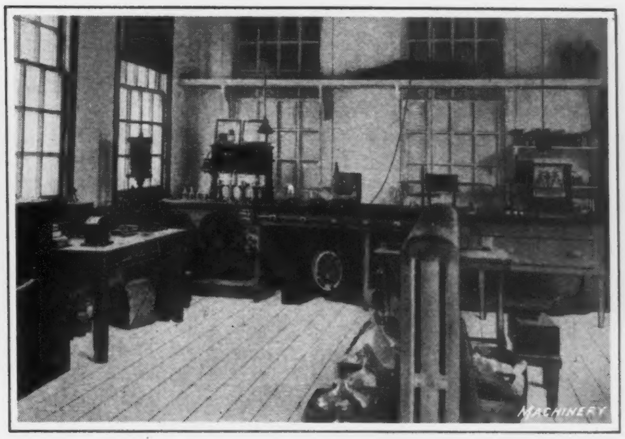


Fig. 16. A Corner of the Chemical and Metallurgical Laboratory where the Quality of Raw Materials and Finished Product is definitely ascertained

tinned to protect it from corrosion. The making of such tubing is done in exactly the same way as the process already described, except that the finished tubing is sent to the tinning department where it is first immersed in a bath of muriatic acid, which serves as a flux to cut any oxide scale or grease off the work, after which the tubes are immersed in a bath of molten solder which tins both the inside and outside of the tube. A view of the tinning department is shown in Fig. 14. In order to obtain a job of good appearance, it is necessary for the excess tin to be removed, and this is done in the following way: While the tube is still hot and the tin in a molten condition, the outside of the tube is wiped with a bundle of jute; and after this has been done, a cork of suitable size is pushed through the inside of the tube to provide for removing the excess tin from this surface.

Engineering and Chemical Laboratory Service

A large part of the tubing made at the Wheeler plant is for use in the construction of condensers, and in this service trouble is sometimes experienced through the corrosive action of certain waters on the condenser tubes. This is a matter that is entirely apart from all considerations of workmanship in making tubing. It is simply a result of the fact that chemical constituents in the water show a tendency to corrode a given kind of tube. To overcome trouble of this kind, the Wheeler Condenser & Engineering Co. maintains a laboratory and is prepared to make technical investigations of all cases of trouble and recommend special metal mixtures for tubing that will be able to overcome existing local conditions. A general laboratory view is shown in Fig. 16.

Two photomicrographs are presented in Figs. 17 and 18 which show the structure of an admiralty brass tube before and after being subjected to the annealing treatment. Every mechanic knows that annealing is resorted to in cases where it is required to remove strains from the metal, and these illustrations show to very good advantage the result of annealing. In Fig. 17 it will be noticed that there are a number of fine lines running across the photograph; these lines are the result of strains which have been introduced in the metal by the mechanical treatment to which it has been subjected. After annealing, no such lines are visible, and this shows that all of the strains have been removed from the metal. The taking of photomicrographs to ascertain if the annealing process has been conducted in a way that assures the removal of all strains from the metal, is only one of the applications of this method.

Photomicrographs are extensively used to determine the homogeneity of alloys from which tubing is made. Sometimes there is a tendency for an alloy to partially separate. This tendency toward separation produces what is known as a "eutectic" in the alloy, and is extremely objectionable from a practical viewpoint, because the eutectic does not bond firmly to the metal adjacent to it, and so produces a weak point at which the tube is likely to break. When tubes break during the drawing process, etc., samples are sent to the laboratory, where the photomicrographs will often show eutectic characteristics; and steps are then taken to correct the process of manufacture.

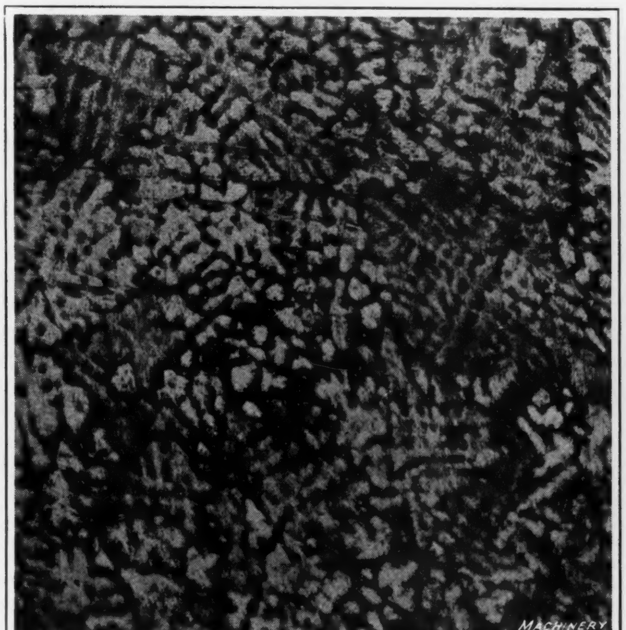


Fig. 17. Photomicrograph of Structure of 70 Per Cent Copper Alloy before working, or as received from Casting Shop

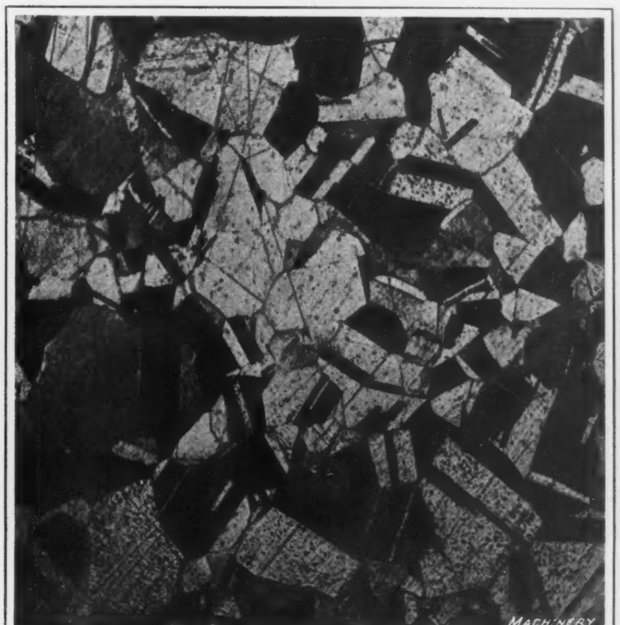


Fig. 18. Photomicrograph of 70 Per Cent Copper Alloy after being annealed and having previously been worked

DESIGNING A LOCKING DEVICE

By VICTOR M. SUMMA
Engineering Examiner, American Brake Co., St. Louis, Mo.

While the simple locking device shown in the accompany- illustration has been used for many years, the calculations required in designing such a device to meet any given requirements of service have been given but slight attention. The following formulas were evolved as a result of experiments and investigations conducted for the purpose of determining why a device similar to the one shown failed to function properly. The formulas are based on a careful analysis of the forces which act on the different members of the device when it is in operation. They enable the locking power of a device of this kind to be determined quite accurately and should therefore prove of value to the designer who is confronted with the problem of designing a device of this type which may be depended upon to develop a given locking power under known working conditions.

Let P equal the force acting on the washer B at the point S, and f and f_1 the frictional resistances between the surfaces of contact N and M of washer B and rod A. It is obvious that there will be no motion of rod A in the direction P (namely, the device will automatically lock itself)

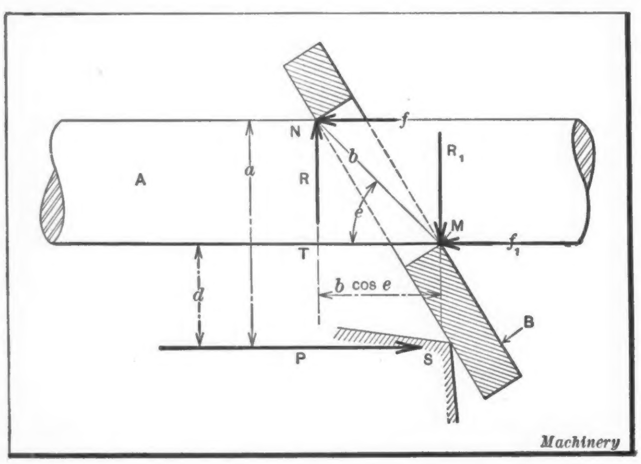


Diagram showing how Forces act on Different Members of the Locking Device

if the developed friction is greater than the actuating force P. In other words there must exist the following relation if the device is to be self-locking:

$$P \text{ is less than } f + f_1 \qquad (1)$$

Also, calling R and R_1 the reactions of P at the points N and M, and noting that they act normal to the surfaces of contact, it is evident that

$$f = kR \qquad f_1 = kR_1 \qquad (2)$$

in which k is the coefficient of friction of the contact surfaces. It is necessary now to ascertain the values of the reactions R and R_1. For equilibrium of rotation the algebraic sum of the moments of the forces P, R and R_1 must be equal to zero. That is, taking moments about points N and M successively, and since by trigonometry $TM = b \cos e$ (where $b = NM$) we have:

$$P \times a = R_1 b \cos e$$

Therefore

$$R_1 = \frac{P \times a}{b \cos e}$$

and

$$P \times d = Rb \cos e$$

Therefore

$$R = \frac{P \times d}{b \cos e}$$

Substituting these values of R and R_1 in Equations (2)

$$f = k\frac{P \times d}{b \cos e} \qquad f_1 = k\frac{P \times a}{b \cos e}$$

and by again substituting these results in Equation (1)

$$P \text{ is less than } k\frac{P(d + a)}{b \cos e}$$

or still better, by solving for k,

$$k \text{ is greater than } \frac{b \cos e}{a + d}$$

Hence, the device will only be able to lock itself if the arithmetical value of the expression $\frac{b \cos e}{a + d}$ (3) is *smaller* than the least possible value of the coefficient of friction k of the material. By choosing a point S so located that the cosine of angle e may be a minimum and $(a + d)$ may be a maximum, it should always be possible to obtain the required condition.

If the force P is relatively great it would be advisable to use a square bar instead of the round rod A, so that the reactions R and R_1 may have a larger bearing surface than that given by the tangential points N and M, and in order to prevent the washer from cutting into the rod.

Example 1—Assuming that the angle e is equal to 50 degrees and that $a = 31/32$ inch, $b = 13/16$ inch, $d = 1/4$ inch, it is required to ascertain whether the device will be self-locking, taking $k = 0.25$ as the coefficient of static friction of steel over steel.

By substitution in Formula (3) we have:

$$\frac{0.8125 \times 0.6428}{1.218} = 0.43$$

a value considerably greater than k, indicating that the mechanism will not work.

Example 2—Find the advantage, if any, when the device is modified so that angle $e = 68$ degrees, $a = 1\frac{1}{4}$ inches, $b = 13/16$ inch, and $d = 1/2$ inch.

Here we have:

$$\frac{0.8125 \times 0.3746}{1.75} = 0.174$$

a value sufficiently smaller than the assumed minimum value of the coefficient of friction as to give reasonable assurance that the device will have a self-locking action.

If the shaft is lubricated, the value of k probably would not be more than 0.12 or 0.14, in which case the angle e should be as near 90 degrees as possible and a and d increased until the fraction $\frac{b \cos e}{a + d}$ is below the minimum coefficient 0.12.

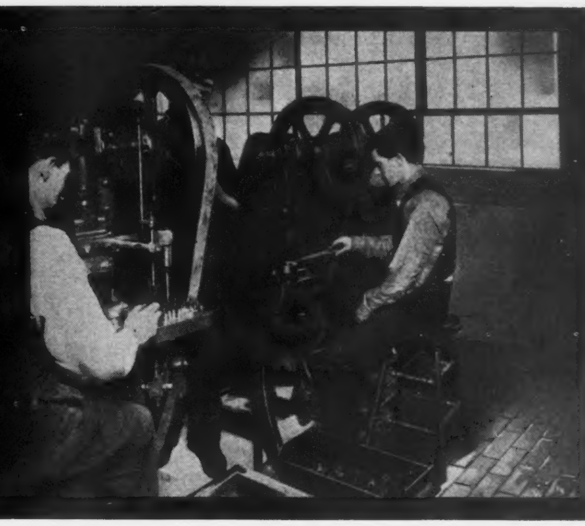
* * *

CAUSES OF PRESENT HIGH OCEAN FREIGHT RATES

The present high ocean freight rates to a large extent hamper the early resumption of foreign trade along the same lines as before the war. Business men engaged in international trade are continually asking: "When will ocean freight rates be lower?" The answer is that it will be a considerable period of time before this will happen, and freight rates will never be as low as they were before the war. The main reasons are as follows: There is a shortage of tonnage, because the losses sustained during the war have not yet been replaced by the building of new tonnage; a large number of vessels are under repairs after the stress and strain of the war service; the various governments engaged in the war still require a large tonnage for transport service; strikes and labor difficulties have prevented the using of existing tonnage to its full capacity during the past year; increased wages have greatly added to the cost of new ships; higher insurance rates must be paid on the increased valuation of ships; in addition, higher costs of repairs and maintenance, increased wages for both officers and crew, heavier bills for their maintenance and other ships' stores, increased dock dues, and much higher prices for coal produce high operating costs. All these factors make it necessary to charge much higher freight rates, and exporters should not anticipate any material change in ocean rates for some time to come. The adverse influence upon international trade that is caused by these high ocean freight rates will doubtless tend to reduce foreign trade, and increased efforts must be exerted to extend trade connections to offset that influence.

Dies for Automobile Oil Filler Cup

By J. BINGHAM
President, The B. J. Stamping Co., Toledo, Ohio



THE dies used in the manufacture of an oil filler cup or breathing tube for an automobile engine, are shown in the illustrations accompanying this article. Each of the dies is illustrated in the order in which it is used, and a detail of the shell is shown as it appears after each operation. The shell is made from cold-rolled strip steel 0.065 inch thick, the blank being cut to a diameter of 6¾ inches.

The blank is cut and the first drawing operation performed by the die illustrated in Fig. 1. This die is of a standard type and is used in connection with the usual rubber buffer attachment. The sheet metal is laid upon the cutting ring *A*, and the blank is cut to the required size as the lower edge of the punch face ring *B* passes the upper edge of ring *A* on the downward stroke of the press ram. The shell is drawn on the forming die *C* as the punch *D* concludes its descent.

The die shown in Fig. 2 is employed to make the three reductions in the diameter of the shell as shown beneath the die. The die as illustrated will produce the shape *A*. In order to reduce the shell to shape *B* after a quantity have been formed as shown at *A*, it is necessary to replace the die ring *D* and punch *E* for those of suitable dimensions. The punch and die ring are again changed in order to produce the shell as shown at *C*. The upper surface of the die ring *D* is hollowed out to the external diameter of the shell to be operated upon, in order to locate it properly for the operation. This die is equipped with an automatic stripping device for forcing the shell from punch *E* upon the return stroke of the press. It consists mainly of the stripper *F* and spring *G*. As the shell is forced through the die on the downward stroke of the press ram the stripper is pushed in an outward direction. When the shell reaches the position shown, the stripper is actuated by the spring and forced toward the center of the die so that when the punch makes the return stroke, the end of the stripper keeps the shell from adhering to the punch, and when the punch has been completely withdrawn the shell drops through the die. The knock-out pad *H* is provided for use in case stripper *F* does not function properly.

Three dies of the type shown in Fig. 3 are used to draw the shell to the shapes *A*, *B*, and *C*. Knock-out devices *D* and *E* are provided in each case for forcing the shell from the punch and die. These dies complete the drawing operations on the shell. The die illustrated at *A* in Fig. 4 trims the edge of the shell at the large end. The shell is placed on the device as shown, the screw *C* acting as a gage to give the shell the proper length. The end of the shell is trimmed as the cutting tool *D* descends into slot *E*, the shell being turned by hand after each stroke of the cutting tool until the entire end has been trimmed. The punch and die shown at *B* in the same illustration cuts a hole in the small end of the shell. There is sufficient clearance between the ring *F* and the die-shoe *G* to permit the cutting ring *H* to be reground a number of times. The punch *J* is equipped with a novel stripping device consisting of stripper *K*, which is held in position on punch *J* by means of screws *M*, and springs *L*. The stripper is forced downward on the return stroke of the press ram by the expansion of the springs, thus forcing the shell off the punch.

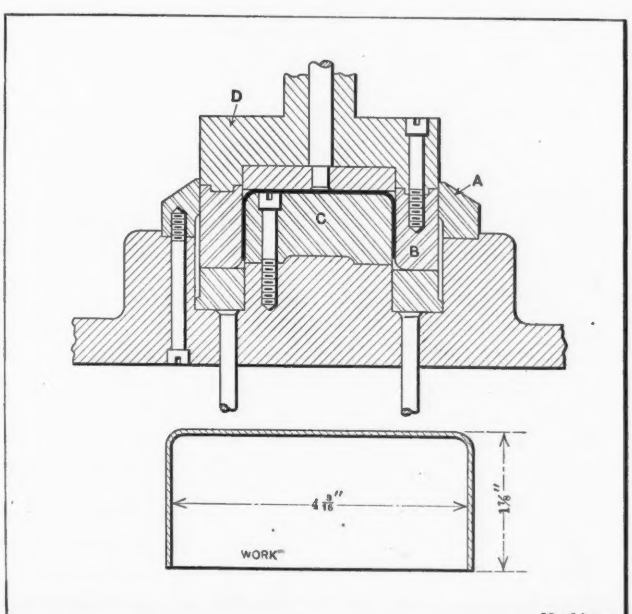


Fig. 1. Blanking and Forming Die which performs First Operation

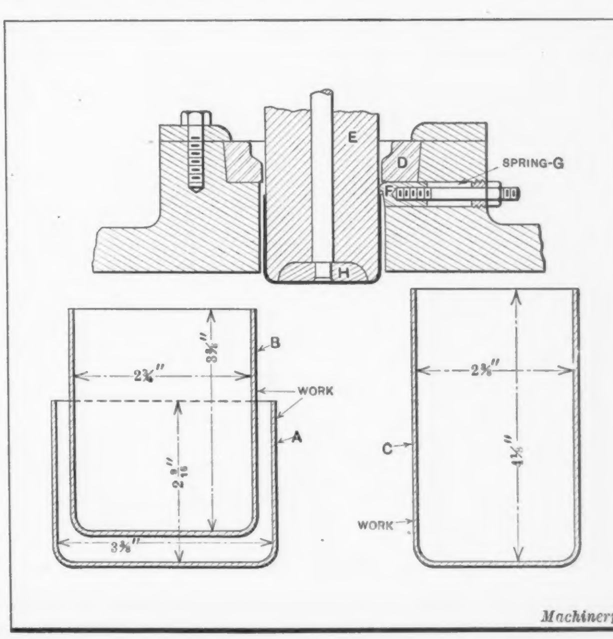


Fig. 2. Die used for making Three Reductions in Shell Diameter

Fig. 5 shows the die that stamps the bead on the large end of the shell. The method of doing this is very similar to the trimming operation performed by the die shown at *A* in Fig. 4; that is, the shell is placed in the die with the large end against the surface *A*, while the beading tool *B* reciprocates and forms the bead on the shell. The shell is also turned by hand in order to allow it to be beaded around the entire circumference. A die of similar design is employed to produce a bead on the small end of the shell.

The die illustrated in Fig. 6 produces the foot-plate which may be seen attached to the detail of the shell in Fig. 7. This part is made from strip metal which is fed through the die opening *C* in the direction indicated by the arrow in the

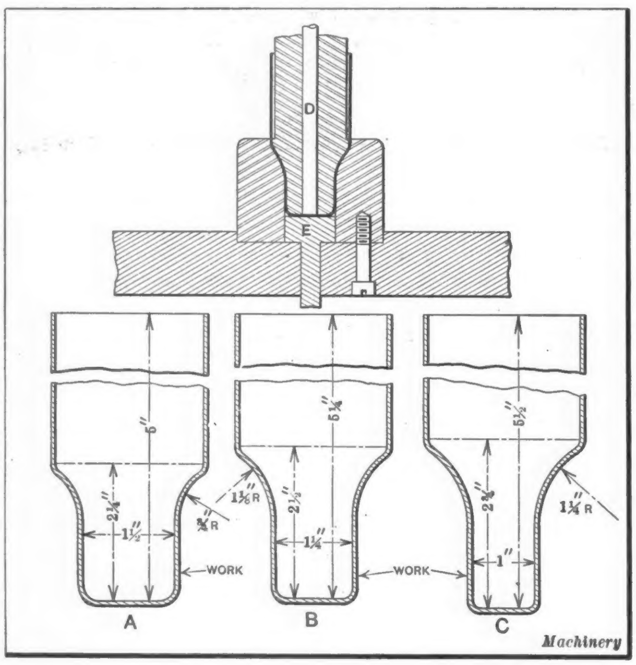


Fig. 3. Type of Die employed to draw the Shell to the Shapes shown

plan view. Two strokes are required to complete one piece, the three holes being punched through on the first stroke, while the blank is cut by the second stroke. It is obvious that after the first operation, a completed piece will be produced with each stroke of the press ram. The construction of the punching tools which pierce the holes in the plate may be clearly seen in the section shown at *A*, while the enlarged sectional view at *B* shows the tool which cuts the blank. The pilots *D* enter the holes cut in the plate by the first operation to locate the plate for the second operation.

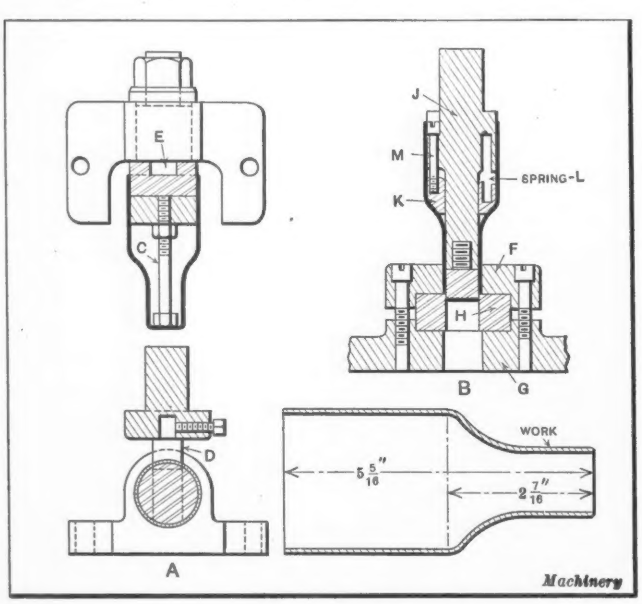


Fig. 4. (A) Die for trimming Large End of Shell. (B) Die for punching Hole in Small End

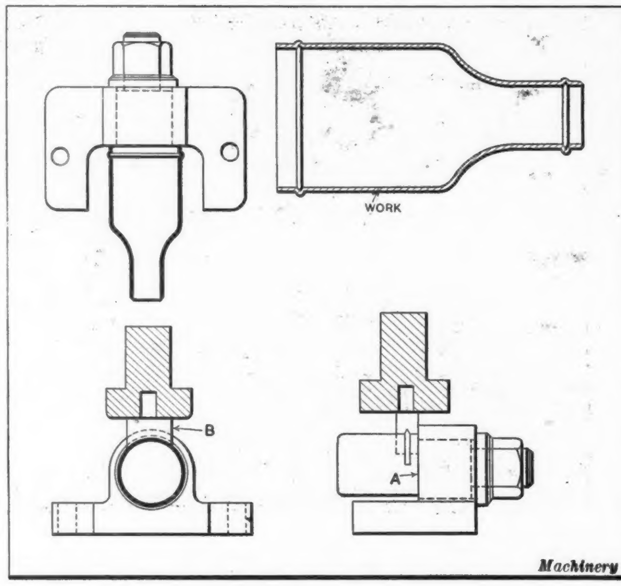


Fig. 5. Type of Die employed for forming the Beads on the Ends of the Shell

The final operation consists of closing the foot-plate on the small end of the shell, which is performed by the die illustrated in Fig. 7. Prior to this operation, the large hole in the foot-plate is reamed to the flared shape which may be clearly seen in the illustration. In this operation, the punch *A* expands the metal to fit the hole in the foot-plate

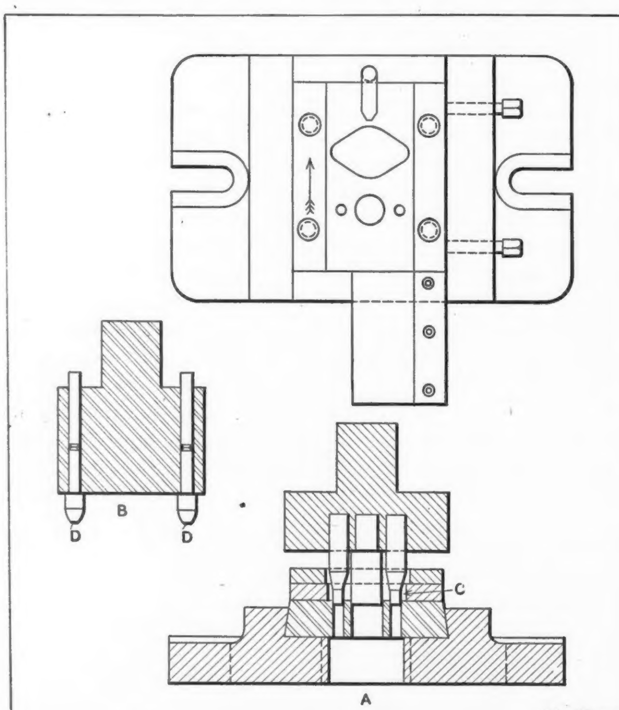


Fig. 6. Combination Piercing and Blanking Die for producing Foot-plate

and at the same time draws the beaded surface up against the other side of the foot-plate, thus holding it securely in place. The construction of the die is as follows: The jaws *B* are hinged on pin *C* and are swung open to permit the insertion of the shell. After the shell has been placed in position, the jaws are locked together by means of handle *D* and pin *E*. This device holds the shell firmly during the operation. The head and body of screw *F* fit in recesses in both jaws and hold the jaws down during the return stroke of the press ram. If this feature were not provided there would be a tendency for the jaws to lift and bend pin *C* and the forming end of punch *A*, resulting in ruining the die. The dies described were made while the writer was superintendent at the Acklin Stamping Co., Toledo, Ohio.

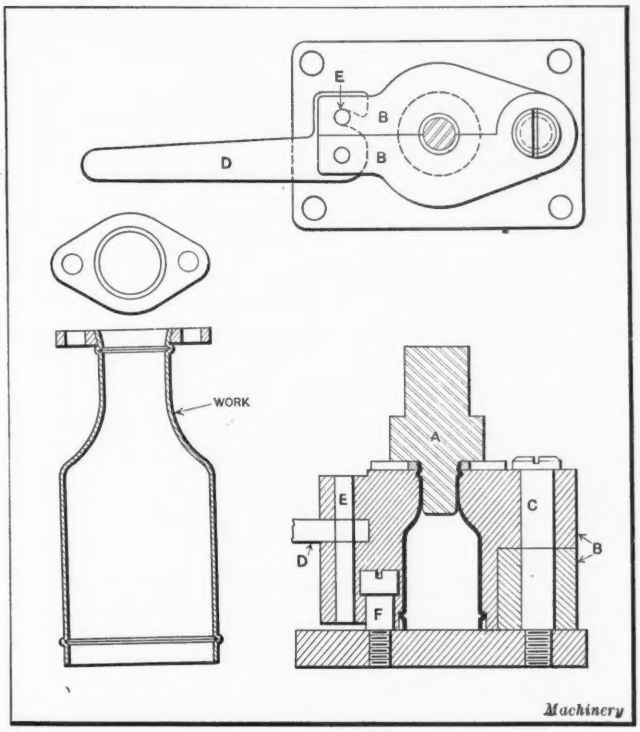


Fig. 7. Device used for holding the Shell during the Final Operation

WAGES AND PROFIT-SHARING

In an address by Charles Piez, president of the Link-Belt Co., Chicago, Ill., before the Illinois Manufacturers' Association, emphasis was placed upon the point that greater production, greater thrift, and frugality are the most effective factors in reducing prices, but increased production cannot be achieved unless wages be based on output instead of on hours worked. Wages based on output, under safeguards that will correct and prevent abuses, should be accepted by organized labor in industries where this practice has been discarded.

Interest in the ownership of a business, according to Mr. Piez, has a steadying, stabilizing effect, but it must be earned through thrift and sacrifice, and not demanded as a right. A real pecuniary interest by the employes is a good thing provided it is paid for. Partnership must carry with it a sense of responsibility in the pecuniary success of the venture, and cannot be helpful or effective if it represents an association in which one partner is purely interested in securing all he can for himself, without thought of the continued strength and success of the venture. The opening up of the opportunity for acquiring a stock interest in an industry should be favored, and that chance given to every workman whose length and character of service justifies it, and who is willing to assume the responsibility to pay for that interest in cash.

* * *

A remarkable record in regard to freedom from accidents is that of the crucible melting department of the Halcomb Steel Co., Syracuse, N. Y. In October, 1918, there were four accidents in this department serious enough so that they resulted in lost time for the workmen. Both the workmen and the man responsible for safety in the plant started the next month with the determination of making a record—no accidents at all. They succeeded in this and succeeded in repeating the same performance from month to month so that from the end of October, 1918, to the beginning of October, 1919, there was not a single lost-time accident in the department. This result is ascribed solely to the exercising of constant vigilance, in the taking care of little things such as prompt attention to minor scratches, the keeping of all tools and appliances in their proper place and in first-class condition, and the elimination of all fooling and horse play in the plant.

PROBLEM IN MENSURATION

By ELMER LATSHAW

The following is another solution of the problem which was solved on page 170 of the October number of MACHINERY. This solution, though very similar to the one that appeared in the May, 1917 number, is much simpler in form and therefore is of more practical value to the toolmaker. Although in the derivation of the formula the solution of a quadratic equation is required, this formula, when once derived, is so simple that anyone who is capable of extracting a square root will have no difficulty in using it. The formula is not only easily applied, but does not involve the use of trigonometry, and is in such simple form that for small and simple numbers the radius R can often be determined by inspection. However, a table of squares for extracting the square root of the number under the radical sign, will greatly facilitate the use of the formula where the numbers involved are large or complex. In the solution of quadratic equations, as is well known, two valves which will satisfy the equation are always obtained. The accompanying diagram illustrates the application of each of these two values.

Case 1—$AB = a$; $BC = b$; $R =$ required radius. Draw AE parallel to BC. Then

$$(AE)^2 + (EO)^2 = R^2$$

But $AE = (b - R)$

and $EO = (R - a)$

Therefore, after substituting and squaring the binomials and simplifying, the equation becomes

$$R^2 - (2a + 2b) R + a^2 + b^2 = 0$$

Solving the above quadratic equation

$$R = (a + b) \pm \sqrt{2ab}$$

By referring to the diagram for Case 1, it will be apparent that the equation $R = (a + b) - \sqrt{2ab}$, is the one to use in this case, since R is less than $a + b$.

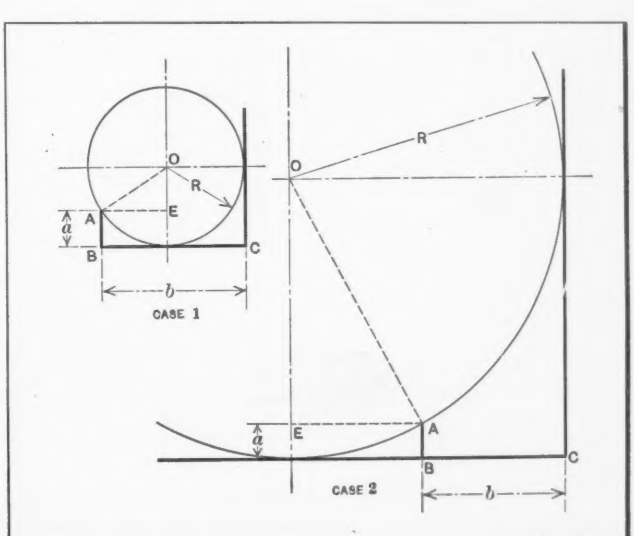
Case 2—It will be seen by following the derivation of the formula used in Case 1 that the formula $R = (a + b) + \sqrt{2ab}$ applies where R is greater than $a + b$, as shown in the diagram for Case 2.

The quadratic equation is generally evaded wherever possible in practical problems, but a careful investigation of the foregoing solution will illustrate the practical value of both roots of a quadratic equation. Applying the formula for Case 1 to the conditions of the problem under discussion, where $a = 1/4$ inch and $b = 1$ inch,

$$R = (1/4 + 1) - \sqrt{2 \times 1/4 \times 1}$$
$$= 1.25 - \sqrt{0.5}$$
$$= 1.25 - 0.70711 = 0.54289 \text{ inch.}$$

For the adaptation of the formula to the conditions illustrated in Case 2,

$$R = 1.25 + 0.70711 = 1.95711 \text{ inches}$$



Diagrams used in deriving the Formulas for the Mensuration Problem

Railway Car Axle Design

By A. L. NICHOLS
Assistant Chief Engineer, St. Louis Car Co., St. Louis, Mo.

IT is not the object of this article to enter deeply into the technical side of the design of axles, but to present some everyday problems of the car designer with their solutions. It is the belief of the writer that the results obtained are sufficiently accurate for all practical purposes. The American Electric Railway Association and the Master Car Builders Association have established standards for steam and electric railway axles, and the tables covering them are presented herewith. For further information and specifications the proceedings of the associations may be referred to. A standard axle may be selected from these tables for most cases; there are sometimes, however, special conditions which make this impractical, and it is with these special cases that this article deals.

In the design of axles we must first determine the stresses to which the axle will be subjected. This can best be explained by considering a practical problem. Let it be required to design an axle for a double-truck, motor-driven car, weighing complete with load (less wheels and axles) 80,000 pounds. As there are four axles, there will be a total load on each axle of 20,000 pounds. The greatest stress will occur when the car is on a curve; therefore we will make our calculations for that condition. There are four component forces which act on the axle of a motor-driven car; the first is that due to the static load of the car and its contents; the second, that caused by the centrifugal force of the car on a curve; the third, that due to the torque of the motor; and the fourth that due to the torque of the wheels when the car is on a curve.

Analysis of the Forces Acting on the Axle

Referring to Fig. 1, it will be seen that the distance from the journal to the center of the rail is 10 inches and that the load on each end of the axle is 10,000 pounds; therefore the bending moment is $10,000 \times 10$ or 100,000 inch-pounds. It will also be noticed by referring to the diagram in the lower part of this illustration that the diameter of the wheel is assumed to be 26 inches; therefore the distance from the rail to the center of the axle is 13 inches, and if the centrifugal force is taken at 0.4 of the load on the axle, the bending moment due to the centrifugal force will be 20,000 $\times$ 0.4 or $8000 \times 13 = 104,000$ inch-pounds. The centrifugal force is calculated from the formula

$$F = \frac{Wv^2}{gR}$$ (MACHINERY'S HANDBOOK, page 286)

in which

F = centrifugal force;
W = weight on one axle;
v = velocity in feet per second;
g = acceleration due to gravity;
R = radius of curve in feet.

It is interesting to note that when the value F exceeds one-half the downward load, the car will overturn. In practice, the value of F is never taken at more than 0.4, and the center of gravity should never be more than 72 inches above the rail. The formula given for finding the centrifugal force was used to plot the chart shown in Fig. 2, on the left side of which the velocity in miles per hour and in feet per second is given, while across the bottom of the chart is indicated the radius of the curve in feet and the equivalent number of degrees of curvature of the rails. From this chart the centrifugal force on any curve up to 400 feet radius and with any speed up to 75 miles per hour can readily be found. Curves having a radius of 35 feet are common in street car work, and the rails are grooved to prevent the car from running off the track. On steam railway and interurban roads it is the general practice to elevate the outer rail in order to overcome, to some extent, the centrifugal force. The chart is not to be used for determining the speed at which a car can travel around a curve, as there are many other conditions entering into this, such as friction between the wheel flange and the tendency of the wheel to mount the rail.

The motor in this particular example has been assumed to have a torque of 175 foot-pounds; the pinion, a pitch radius of 1.86 inches; and the axle gear a pitch radius of 8.45 inches.

Fig. 1. Illustrating Application of Stresses exerted on Car Axles due to Static Load and to Centrifugal Force on Curves

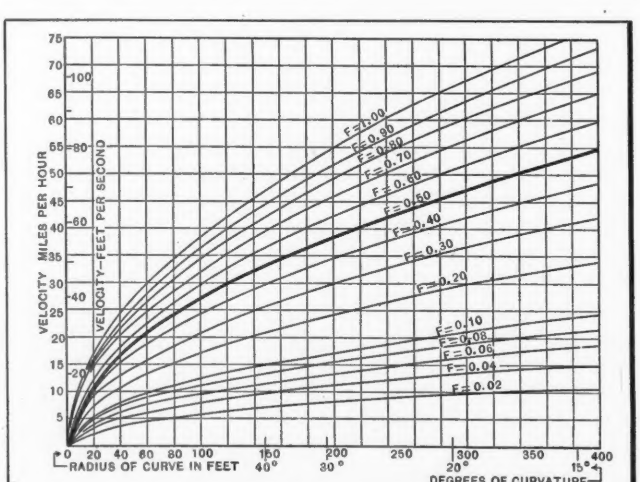


Fig. 2. Chart for Use in determining the Centrifugal Force exerted on Car Axles when turning a Curve

Then $175 \times 12 \div 1.86 = 1129$ pounds, and $1129 \times 8.45 = 9540$ inch-pounds torsion in the axle. As the outer rail of a curve is longer than the inner rail and as the wheels are fixed to the axle, one of the wheels must slip, producing a torsion in the axle which is equal to the load of one end of the axle multiplied by the coefficient of friction multiplied by the radius of the wheel. The coefficient of friction is the ratio of the maximum tractive effort to the load on the wheel, and on a dry rail, well sanded, may equal 30 per cent of the load. Then, $10,000 \times 0.30 = 3000$ pounds, and $3000 \times 13 = 39,000$ inch-pounds torsion in the axle. The torque of the wheels in steam railway practice is not so pronounced as in street railways, as the curves are not nearly so sharp on the steam roads. It is the usual practice to make car wheels with a taper of one inch in twenty-five on the tread, which gives a smaller diameter on the outside of the wheel. The rails are laid to a wider gage on the curve and the centrifugal force will carry the car to the outside rail and thereby change, to some extent, the diameters of the wheel. This does not occur, however, after the wheels have become worn down.

Calculating the Size of the Axle

Having determined the stresses in the axle, and the forces which cause them, we will now calculate the size of the axle required. This may be done by the use of the formula for combined bending and torsion moment:

$$SZ = \sqrt{M^2 + N^2}$$

in which

S = safe fiber stress per square inch;
Z = section modulus for bending;
M = bending moment in inch-pounds;
N = torsional moment in inch-pounds.

The total bending moment, in the example being considered, is 100,000 inch-pounds (static load) plus 104,000 pounds (centrifugal force), or $M = 204,000$ inch-pounds. The total torsional moment is 9540 inch-pounds plus 39,000 inch-pounds, or $N = 48,540$ inch-pounds. Extracting the square root of the sum of the squares of these two values and dividing the result by the safe fiber stress S for axles, that is, by 18,000 pounds,

$$Z = \frac{\sqrt{43,972,131,600}}{18,000} = \frac{209,695}{18,000} = 11.1$$

To find the section modulus of round bars use the formula given on page 311 of MACHINERY'S HANDBOOK,

$$Z = \frac{\pi d^3}{32} = 0.098\, d^3$$

in which 0.098 is a constant and d the diameter of the bar. Referring to Table 1 of motor axles, we find that the 4¼- by 8-inch axle of 22,000 pounds capacity has a diameter of 5½ inches and hence a section modulus of 16.3, which is the correct axle to use. The section modulus 11.1 is for the axle when it has become worn to the removing point, and provision must be made in the new axle for wear; therefore, the axle selected is slightly larger than would be required if this allowance were not made. The pressure on the journal should never exceed 325 pounds per square inch of projected area and should be kept as much below this as possible. The ratio of the length of the journal to its diameter should be about 1.8.

Bending Moment Diagram for Non-Motor Car Axles

A. Stucki, formerly chief engineer of a large car company and inventor of the Stucki frictionless side bearing, has published a bending moment diagram, Fig. 3, by means of which the required strength of axles for non-motor cars or trailers may be graphically determined when laying out the design. Referring to the diagram, Q represents the load on one axle, and the horizontal force due to the centrifugal force and the swaying of the cars on curves is taken as $0.4Q$; this includes the benefit derived by raising the outer rail, and is the result of experiments made under ordinary track conditions at the highest safe speeds. The point o is the center of gravity of the car and its load, and the line oE is the resultant of the horizontal force $0.4Q$ and the vertical force Q. From the head of the right-hand rail draw T_1O at right angles to the coning of the wheel tread intersecting the center line of the axle at Q_2; similarly, draw TO from the other rail head intersecting the axle center line at Q_1. Extend oE to point O in one direction, and to the center line of the axle in the opposite direction intersecting it at E_1. From these three points E_1, Q_1, and Q_2, drop perpendiculars as shown in the diagram.

Lay off on the auxiliary diagram shown in the upper left-hand corner of the illustration, a vertical line AC to any convenient scale (preferably 1 inch = 2000 pounds) so that its length represents to scale the vertical load Q. Locate the point v horizontally 10 inches to the right of the line AC and vertically one-third or one-fourth of its height from the bottom, and connect A and v. Then, in the large diagram drop perpendiculars from P and P_1—the centers of the journals—to points p and p_1. Draw a line from p parallel to Av until it intersects the perpendicular drawn from E_1 at point e. Connect C with v and draw ep_1 parallel to Cv. Connect p and p_1 and draw vB in the auxiliary diagram, parallel to it. Line AB represents to scale the load at P and line BC represents the load at P_1.

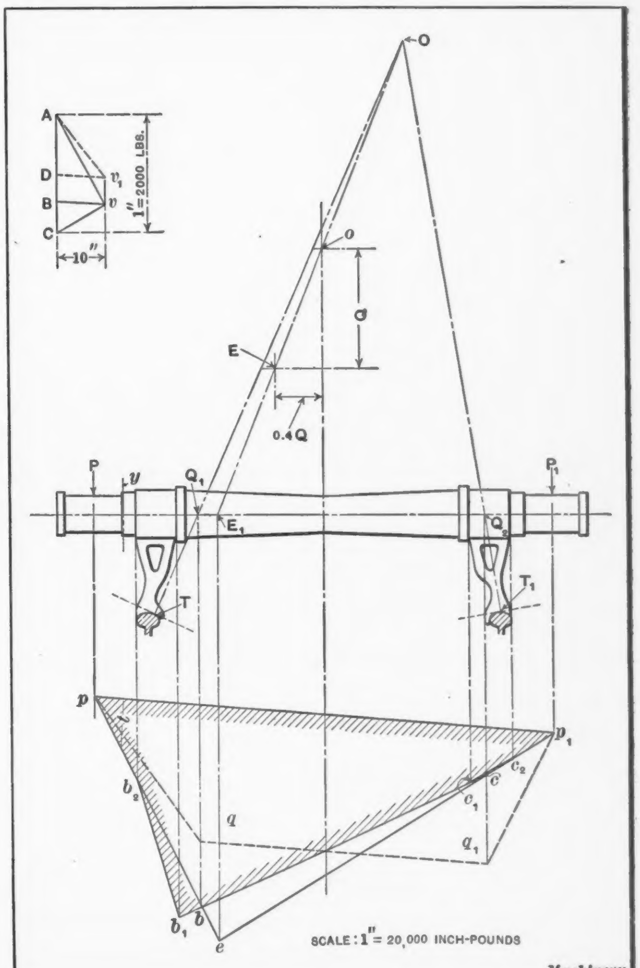
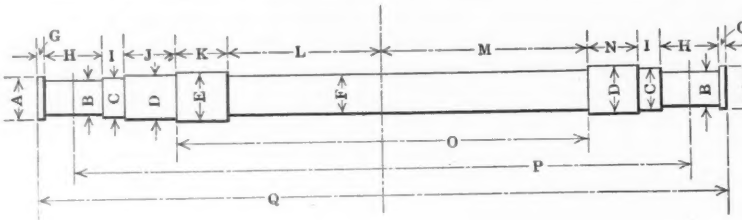


Fig. 3. Bending Moment Diagram for Non-Motor Car Axles

Drop perpendiculars from the hub faces of the wheels terminating at points b_1, b_2, c_1, and c_2. Draw cb and extend it to b_1 and connect b_1 with b_2 and also c_1 which is located on line cb, with c_2. The link polygon pb_2, b_1, c_1, c_2, p_1 is the moment diagram for the assumed load and is drawn to a scale of 20,000 inch-pounds to the inch, since the scale of load was assumed to be 2000 pounds = 1 inch with the length of the lever-arm Bb equal to 10 inches. The length of any perpendicular drawn from line pp_1 included in the shaded portion of the diagram, corresponds to the moment in inch-pounds of the corresponding section of the axle. For ex-

TABLE 1. PROPORTIONS OF MOTOR CAR AXLES
(ADOPTED BY A. E. R. A.)



Size of Journal	Load Capacity, Pounds	Dimensions, Inches																
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
3¼ by 6	9,000	3⅞	3¼	3¾	3 15/16	4	3½	½	6	2½	10 5/16	6⅛	12 11/16	17 5/16	11 13/16	36⅛	69¼	76¼
3¼ by 6	13,000	3⅞	3¼	3¾	4 7/16	4½	4	½	6	2½	10 5/16	6⅛	12 11/16	17 5/16	11 13/16	36⅛	69¼	76¼
3¾ by 7	15,000	4¾	3¾	4¾	4 15/16	5	4½	⅝	7	2½	6	6⅛	17⅞	24	6	48	72	80¼
3¾ by 7	16,000	4¾	3¾	4¾	4 15/16	5	4½	⅝	7	2½	4⅝	6⅛	17⅞	24	4⅝	48	69¼	77½
3¾ by 7	12,000	4¾	3¾	4¾	4 15/16	5	4	⅝	7	2½	4⅝	6⅛	17⅞	24	4⅝	48	69¼	77½
3¾ by 7	14,000	4¾	3¾	4¾	4 15/16	5	4½	⅝	7	2½	7½	6⅛	17⅞	24	7½	48	75	83¼
4¼ by 8	18,000	5¼	4¼	5¼	5 15/16	6	5	⅝	8	2	7½	6⅛	17⅞	24	7½	48	75	84¼
4¼ by 8	22,000	5¼	4¼	5¼	5 15/16	6	5½	⅝	8	2	7½	6⅛	17⅞	24	7½	48	75	84¼
5 by 9	27,000	6⅛	5	6⅛	6 15/16	7	6	¾	9	2	6½	6⅛	18⅞	25	6½	50	76	86½
5 by 9	31,000	6⅛	5	6⅛	6 15/16	7	6½	¾	9	2	6½	6⅛	18⅞	25	6½	50	76	86½
5½ by 10	38,000	6⅝	5½	6⅝	7 15/16	8	7	¾	10	2	6½	6⅛	18⅞	25	6½	50	77	88½

Machinery

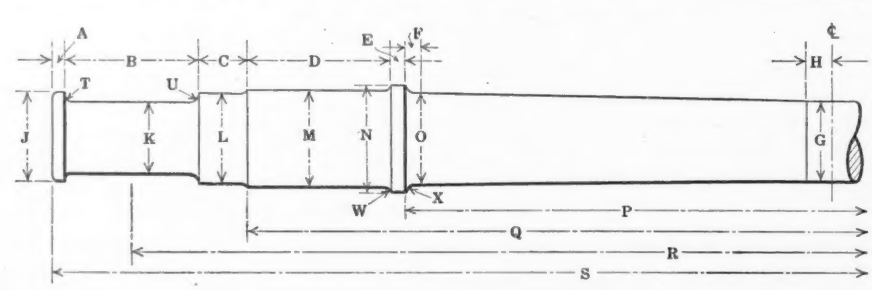
ample, the line t actually measures, by the scale used in diagram ACv, 7.75 inches, which multiplied by the load, 20,000 pounds, gives 155,000 inch-pounds as the moment of the section at y. In order to find the bending moments in the axle, if the centrifugal forces are disregarded, move point v vertically upward so that a line drawn from D which is half way between A and C and parallel to Bv, will pass through the point v_1. Connect A with v_1 and draw a line parallel to it from p (in the moment diagram) until it intersects the perpendicular dropped from Q_1 at point q. From q draw a line parallel to Dv_1 until it intersects the perpendicular dropped from Q_2 at point q_1. The vertical distance between the lines pp_1 and qq_1 represents the moments for the shank of the axle.

Having graphically determined the bending moments M, throughout the length of the axle, next calculate the sectional modulus Z at various points, using the familiar formula for bending, $M = SZ$, or $Z = \frac{M}{S}$, S being the safe fiber stress of the material. Transposing the formula $Z = \frac{\pi d^3}{32}$, $d = \sqrt[3]{\frac{32Z}{\pi}}$, from which the diameters may be readily found. After a sufficient number of diameters have been obtained at different points, the theoretical shape of the axle can be sketched in. To allow for wear and for imperfections in the material, the diameter of the journals is usually made ½ inch larger than the theoretical diameter; the dustguard seat is made ¼ inch larger; the wheel seat is made ¼ inch larger; and the center of the axle ⅛ inch larger. The axle should never be allowed to wear below the theoretical size determined. To compensate for lateral wear on the axles and brasses, the loads P and P_1 should be assumed as being applied ½ inch outward from the center of the journals.

* * *

The American Woolen Co. has formed a corporation for the purpose of constructing houses to be sold at cost to its employes. An initial payment of only 5 per cent of the construction cost will be required, the remainder forming a mortgage held by the company. The plans of the houses will be standardized, but each will have an original architectural treatment. This is an effort to solve the labor problem in the right way. By helping the employes to become property owners, the company will do a great deal more to prevent future labor troubles than by any other welfare work.

TABLE 2. PROPORTIONS OF TENDER AND CAR AXLES
(ADOPTED BY M. C. B. AND M. M. A.)



Size of Journal	Load Capacity	Weight	Dimensions, Inches																					
	Pounds		A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	W	X
3¾ by 7	15,000	420	⅝	7	2½	7 11/16	13/16	23/32	4¼	1½	4¾	3¾	4¾	5⅛	5½	4⅞	46	63	75	83¼	¼	¼	¾	1
4¼ by 8	22,000	520	⅝	8	2	7 11/16	13/16	23/32	4¾	1½	5¼	4¼	5¼	5¾	6⅛	5 7/16	46	63	75	84¼	¼	⅝	¾	1
5 by 9	31,000	680	¾	9	2	7 11/16	13/16	23/32	5⅜	1½	6⅛	5	6⅛	6½	6⅞	6 3/16	46	63	76	86½	⅛	¾	¾	1
5½ by 10	38,000	830	¾	10	2	7 11/16	13/16	23/32	5⅞	3	6⅝	5½	6⅝	7	7⅞	6¾	46	63	77	88½	⅛	¾	¾	1
6 by 11	50,000	1000	⅞	11	2¼	8¼	1¾	¾	6 7/16	3	7¼	6	7¼	7⅝	8	7 3/16	42½	62½	78	90¾	⅛	¾	¾	1

Machinery

Cadillac Stock-room Methods

The Manner in which the Cadillac Motor Car Co. Has Solved Some Difficult Stock-keeping Problems

FLUCTUATIONS in the price of tools and other supplies that are used in the manufacturing departments of industrial plants often make it a difficult matter to accurately distribute the cost of such items among the various departments to which they are finally delivered. Where different kinds of tools and supplies are constantly being bought, each shipment is delivered with an invoice, but it rarely happens that the supply on hand has been completely exhausted at the time a new shipment is received. Obviously, such a condition would frequently result in a shortage of tools that would retard production; hence, the trouble in adjusting accounts. If the price has either increased or decreased, it will be apparent that some special precaution must be taken to enable items which have been bought at two different prices to be distributed among manufacturing departments, with a correct charge made against each department.

Either of three different methods of procedure may be adopted in order to accurately adjust accounts to compensate for price fluctuations. The first and most obvious method of procedure is to keep separate accounts for different lots of a given item, which have been purchased at different prices, so that each department may be charged according to the original purchase price. This plan is feasible in the case of small or medium-sized plants, where the volume of tools and supplies to be handled is not very great. The second method of procedure is to make a practice of charging the various items to the different manufacturing departments in which they are used, at the price at which the last lot was bought. This method simplifies the work of accounting, but it is almost sure to cause serious discrepancies in balancing up accounts at the end of the year.

It will be of interest to note how this method has worked out in the large manufacturing plants of this country within the last few years. In 1915, the abnormal demand from Europe was responsible for a rapid rise in the cost of all kinds of manufacturing equipment. Each time a new shipment of tools would be received, all tools of that type still on hand in the stock-room would be immediately appraised at the price appearing on the last invoice, and as prices were constantly rising, such a practice would mean giving the firm a fictitious profit on those tools which remained on hand at the time the next shipment was received. This would result at the end of the fiscal year in a large balance showing on the credit side.

While visiting the Cadillac Motor Car Co.'s plant, the writer discovered that these problems of stock-keeping have been solved by the third system of cost accounting mentioned at the beginning of this article. This system consists of figuring the average price of all tools of a given type, which are on hand in the stock-room at the time each new shipment of tools of that type is received. As a simple example, suppose there are twelve twist drills on hand which cost $1 each, when a new shipment of four dozen drills is received, which were bought at $1.10 each. The average price of twelve drills at $1 each and forty-eight drills at $1.10 each will be $1.08; and all departments calling for drills from the stock-room will now be charged at this price. Where such a practice is followed, there is no error in cost accounting, and as a result, the accounts should balance exactly.

Fig. 1. Drawers for the Folios on which Stock-room Records are maintained

While working out the details of applying this system in the Cadillac plant, the general stores department adopted the use of Burroughs calculating machines to facilitate the work of arriving at average prices of the great variety of different items that are always on hand in the stock-room. A further improvement was made by installing special Burroughs bookkeeping machines to maintain a record of the quantity of each item which is on hand after making a delivery to some department of the plant, and the cash values of both the items delivered to that department and those which remain in the stock-room. It will be apparent from Fig. 2, which shows one of the

loose-leaf folios on which these records are kept, that the system has been worked out in such a way that both the quantity of tools on hand and the cash value must balance; otherwise, an investigation will be immediately instituted to discover the cause of error and make the necessary correction.

The Burroughs bookkeeping machines used for this purpose are of standard design, except that they are furnished with a special keyboard and characters to meet the special requirements of the Cadillac Motor Car Co.'s cost accounting system for the stock-room. Fig. 1 shows a number of work of balancing up the folios has been completed, the file is turned over to an order clerk, who makes out a requisition calling upon the purchasing agent to issue orders for the various tools and supplies that are required. It will be of interest to note that the markers are of such a shape and size that it is impossible to drop them into the file in such a position that they will be concealed by the folios, thus preventing the issuance of a purchase order for the tools or supplies that are required. For a complete description of the stock-room system used at the plant of the Cadillac Motor Car Co., the reader is directed to two articles entitled

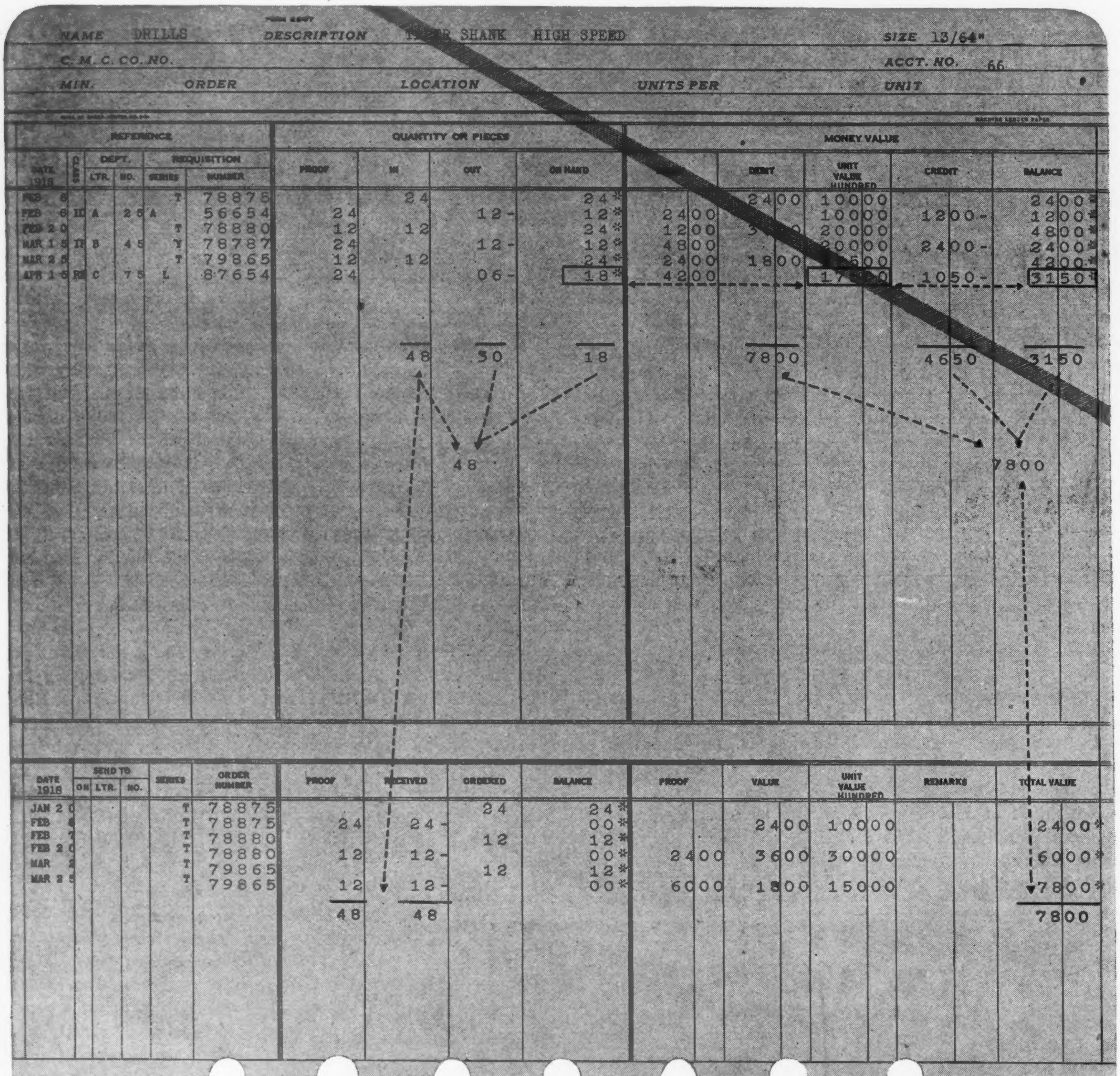


Fig. 2. One of the Cadillac Stock-room Records made up on the Burroughs Bookkeeping Machine

the files in which the folios are kept, and it may be of interest to know that when the stock of any tool, which is on hand in the store-room, has been reduced to a specified minimum, which varies according to the nature of the item, an order is at once issued to purchase a specified number of the tools, which also varies in different cases.

When the operator of the bookkeeping machine balances a folio and finds that the minimum number has been reached, a marker is at once dropped into the folio at this place. It will be apparent from Fig. 1 that the drawers are of greater width than the folios, the reason being to provide a clearance space into which the markers can project. Then when the "Tool System of the Cadillac Motor Car Co." published in the June and October, 1916, numbers of MACHINERY.

* * *

A movement has been started by James A. Farrell, chairman of the National Foreign Trade Council, and president of the United States Steel Corporation, to endow a school of foreign commerce and service on a large scale at Georgetown University, Washington, D. C. It is intended that the school shall work along broad business-like policies. In the curriculum, special attention will be paid to the teaching of foreign languages in a manner that will make these studies of commercial rather than of literary value.

The Machine Tool Industry

THE domestic market is still capable of absorbing practically the entire output of the machine tool builders, and in many lines deliveries are quoted far ahead. The foreign trade situation is somewhat upset by the conditions of the foreign exchange rates, a subject which is dealt with in greater detail in the article "American Machine Tool Trade Abroad" beginning on page 509. Every indication points to continued prosperity in the industry, and as the general business conditions in the United States appear to be as favorable as the conditions in the machine tool industry, there is every reason to believe that the present prosperity is built on a firm basis. There is a lack of goods in practically every line of manufacture, the demand exceeding the supply; and in many industries the production capacity appears to be as yet much less than present consumption. There has been a considerable expansion of the textile industries, and yet there appears to be a scarcity in the products of this industry. In New England the expansion of the textile mills has reacted favorably on the machine tool industry, as regards the demand for machine tools; but on the other hand, the textile mills have absorbed labor that otherwise would have been available in other industries. In the Middle West, the automobile industry, which has been responsible for a greater demand for machine tools than any other line of manufacture, has also taken a large part of the labor supply, thereby somewhat restricting the maximum output of the machine tool builders.

The automobile industry is preparing for another busy year, and it is estimated that the planned production for 1920 is at least 20 per cent greater than the output in 1919. Possibly, however, the situation in the steel market will make it necessary to somewhat curtail this estimated production, as some of the classes of steel used in automobile building, especially sheet steel, are difficult to obtain excepting on very long deliveries.

Prices in some lines of machine tools like sensitive drilling machines, some kinds of grinding machines, and some sizes of turret lathes, have, according to reports, been increased, to take care of the constantly growing expenses for materials and labor. As indicated by the comparative price increases for different classes of machine tools published in MACHINERY last August, all of these lines of machines had increased much less in price than the average increase for the whole machine tool trade, so that the present increases may be considered merely an effort to equalize the selling price and the cost of production.

Predicted Scarcity of Steel

Even previous to the strike in the steel industry, there was danger of shortage of steel of certain kinds, because the demands of some of the manufacturing industries exceeded the capacity of the steel mills. The strike naturally tended to augment this difficulty, and there is now a decided shortage in certain kinds of steel, particularly sheet steel. The United States Steel Corporation, according to a statement made by Judge Gary, has announced that the present policy of the corporation is to adhere to the selling prices agreed upon by the Industrial Board at Washington on March 21, 1919. The Steel Corporation therefore will not raise prices at the present time, although the demand for its products is such that prospective purchasers would be willing to pay materially larger prices to obtain immediate deliveries. It is stated, however, that some of the independent mills have in effect increased their prices, if not in theory, at least in practice. While they will adhere to present prices on orders for long deliveries, premiums are charged for deliveries within a specified time, these premiums varying from one-half cent a pound to one cent a pound on certain grades of steel and for deliveries within from three to six months. Makers of automobile pressed parts have, in some instances, refused orders from their customers, because of their inability to obtain sheet steel for early deliveries.

In the machine tool industry it does not appear that the steel situation will have any adverse influence, as most of the machine tool manufacturers had large quantities of both steel and pig iron on hand at the signing of the armistice; in fact, some report that they have supplies sufficient not only to tide them over the present alleged shortage, but that they are also able to sell some of their surplus stock; hence, they will be independent of the jobbers in steel, who are said to have bought up much of the available supply in sight at the beginning of the steel strike, and who are now quoting prices considered rather high for immediate deliveries.

The Labor Situation

While the labor situation now appears to be satisfactory in so far as comparative absence of disturbances in the form of strikes is concerned, there is a marked shortage of both skilled and unskilled labor in most localities where machine tool plants are located. Throughout New England, complaints are made that it is difficult to obtain toolmakers and skilled machinists, and that it is not a question of wages, because there are not enough men of this type to fill the demands of the industry. Unskilled labor is also scarce because there has been no immigration to supply the cheaper grades of labor and also because some of the industries, particularly the textile industry, have drawn heavily upon the present available supply. Some plants are not able to make use of their full machine capacity because of their inability to obtain a sufficient number of skilled men. The wage situation seems to have gradually reached a level at which wages, the cost of living, and the prices at which the manufactured products are sold, seem to bear approximately the same relation to each other as they did previous to the war.

Need for Apprenticeships

The scarcity of skilled mechanics brings up the question of apprenticeship. Many manufacturers realize the absolute necessity of some steps being taken to revive the old-fashioned apprenticeship on modern lines. Just how this can be done in the case of the small shop is open to discussion, and a satisfactory solution has not as yet been presented. In the case of large plants, of course, apprentice schools are maintained and these are made attractive to the boys taking the courses because of the theoretical as well as practical training that is given. At the present time, however, when a boy can get a comparatively high wage at once by operating a machine tool on repetition work, it is difficult to persuade him to accept a lower rate of pay for a period of four years in order that he may learn a trade first and after that time become capable of earning a higher wage. A concerted effort on the part of manufacturers, however, doubtless would bring results. Some firms well known in the machine tool fields, have for years maintained very successful apprentice schools, and in a few instances, smaller firms who could not each individually maintain such a school, have cooperated in establishing a school where the theoretical instruction was given, while the practical instruction would be taken care of in each individual plant. Present conditions have forced the problem definitely to the front, and when the importance of the problem is thoroughly recognized, doubtless a satisfactory solution can be found.

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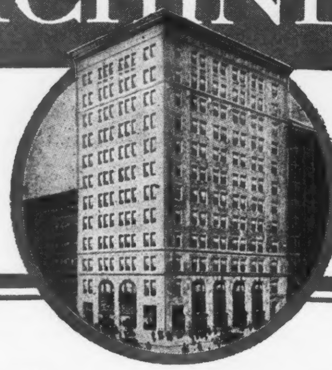

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ECONOMICAL SHOP PRACTICE

Sometimes advertisements of milling machines and planers call attention to the large volume or weight of metal that can be removed per minute by the machine. The capacity of a machine expressed in this manner indicates to a man familiar with shop practice the character of the design and workmanship of the machine, and is an important factor to be considered in buying such equipment. But the claims made, while unquestionably accurate, often far exceed any practical conditions of operation that should be required of a milling or planing machine. If the castings or forgings have so much metal left on them to be removed, it is not a superior type of machine that is required, but an investigation into the responsibility for a wasteful practice; because there must be something radically wrong in the work of either the pattern shop or the tool-room, if the patterns from which the castings are molded or the dies used for the drop-forgings leave so much metal for machining.

To prevent waste in the manufacturing processes, it would be good practice for the production manager of the plant to check up the dimensions of patterns and dies used in the making of castings and forgings. If too much metal is left to be removed by machining, it is evident that the production obtained in the machine shop will be reduced, because as the depth of cut increases it is necessary to slow down the rate of feed, and consequently the number of pieces machined per day is reduced. Generally speaking, for castings, it will be found that in all ordinary cases a maximum allowance of ⅛ inch for machining is adequate; and on drop-forgings the excess metal need never exceed 1/16 inch in depth, except in very unusual and special cases; infact, it is frequently possible to work to even closer limits than 1/16 inch.

* * *

PRACTICAL RESULTS FROM ENGINEERING COOPERATION

The work of the convention of the Society of Automotive Engineers held during the past month in New York City shows what can be accomplished when manufacturers and engineers actively cooperate for the purpose of improving their product and reducing its cost. No commercial or engineering organization has done more toward product standardization than this society, its main efforts having been concentrated on that work. Great economies and a speeding up in the production of automobiles and motor trucks of all kinds have resulted from this broad and intelligent procedure.

C. F. Clarkson, the general manager, calls attention to some noteworthy results of the society's work—including specifications for automobile materials which are now used in other engineering fields; the elimination of minor differences in specifications, effecting a reduction in the selling prices of materials and enabling manufacturers to obtain them from stocks at the warehouses; the standardization of spark plugs, screws, bolts and nuts, many ignition appliances and electrical apparatus, pistons, piston-rings, carburetors, lock-washers, etc., making it possible to obtain repair parts quickly and to use them interchangeably on different makes of cars and trucks.

The society has actually established nearly 300 different mechanical and material standards, and has accomplished this result by methods which have in no way impeded the improvements in automobile construction. On the contrary, by simplifying the routine work of draftsmen and engineers, a considerable part of their time has been available for working out improved construction and the introduction of new features such as make the designers' work really worth while. The continuous decrease in the cost of automobiles previous to the war, and the fact that their prices have not been increased in anything like the same ratio as those of other mechanical products, show the importance of the results achieved by the automobile engineers and manufacturers through their standardization work.

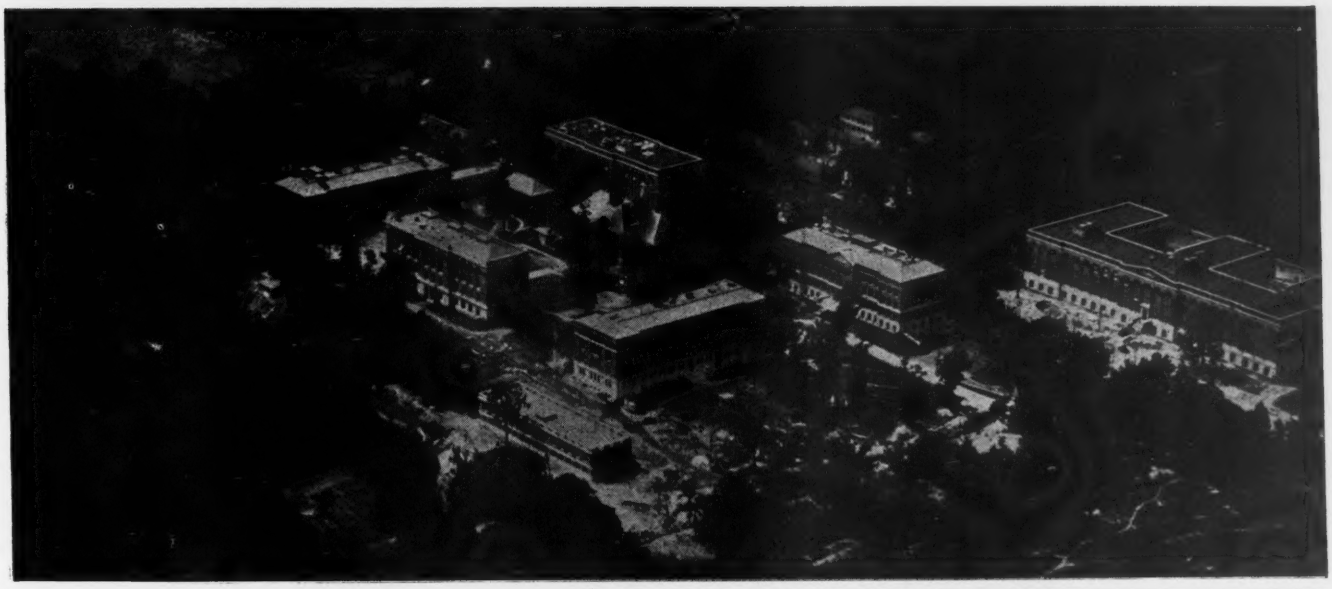
At present the society has at work hundreds of representative engineers throughout the country endeavoring to determine new standards that will be generally acceptable. Nearly one hundred additional standards are established yearly, many of which benefit all the mechanical industries, and all the data thus acquired are generally accessible in handbooks published by the society, which contain records of the standardization and recommended practices that have been adopted.

* * *

PUBLICITY WILL HELP

It has been frequently stated that a considerable part of the industrial unrest of the day is due to exaggerated ideas of profits that labor agitators have systematically implanted in the minds of workers. During the Seattle strike, for example, agitators stated in open meetings that the largest shipyard in Seattle was earning $60 per day per man, out of which the worker himself received only $6. This statement was widely accepted as true by the men, and many newspapers, eager for sensational news, helped to spread it broadcast. Yet the facts were that the total output of the yard per man per day amounted to only $15, and out of the $15 not only the man's wages of $6 had to be paid, but the cost of all the material he used, his proportion of the cost of the buildings and special equipment required, the taxes and insurance, interest on borrowed money, the salaries of foremen and executives, the coal used in producing power, the indemnities payable in cases of accident, and the many other costs that must be met in such an industrial enterprise. The stockholders received their share only after all these different items had been paid.

When employers generally will combine to furnish their employes with accurate and enlightening information on the costs of their business and the items of expense involved, the effect of such false statements can be counteracted; but so long as employers virtually confirm their truth by silence, the employes will continue to be influenced by false or exaggerated statements about profits—and to act on them.



The Work of the Bureau of Standards

DURING the last few years the functions of the Bureau of Standards have been greatly increased, its activities during the war, particularly, tending to prove its importance in the industrial and engineering fields. A number of new buildings have recently been added, especially with a view to furnishing ample and well-equipped laboratories for industrial testing and research. It is evident that the maintenance of correct standards, not only of measurements and weights, but also of quality and of performance—as in the case of engines, boilers, pumps, electrical machinery, etc.—calls for continuous and scientific investigations of the highest order, and involves competent expert services and the best scientific equipment. When this is accomplished, there still remains the serious problem of making the results available and useful in the industries.

One of the functions of the Bureau of Standards is to compare with its own standard of measurements, the measuring instruments used by states, cities, scientific laboratories, educational institutions, and commercial corporations. The Bureau also gives advice concerning these standards and their use, and many questions of disagreement either between corporations, or between the public and a corporation, involving the use of standards, are referred to the Bureau for advice or adjustment. The Bureau also certifies the accuracy of standards of measurement, such as gages, and in addition publishes a great deal of information relating to measurements and standards of all kinds, in the form of small booklets, each dealing with one definite subject. Numerous tests and investigations are carried on in this connection.

The materials of construction are also dealt with by the Bureau. In the mechanical engineering trades, the materials of the greatest interest are steel, brass, and bronze, the characteristics and properties of which are investigated in the metallurgical laboratory. In this laboratory part of the gage work is also done.

Relation of the Bureau of Standards' Work to the Industries

The activities of the Bureau of Standards are fundamentally concerned, either directly or indirectly, with the improvement of methods of production or the quality of the output of the industries. The Bureau occupies somewhat the same position with regard to the manufacturing plants of the country that the Department of Agriculture does to agricultural interests. Many industries are just beginning to realize the importance of precise methods of measurement and scientific investigation, which in practically every case involves some kind of measurement.

As pointed out in the annual report of the director of the Bureau of Standards, it is upon quality as well as upon price that competition must finally depend, whether in domestic or foreign commerce. The use of exact methods and scientific results is the greatest factor in the improvement of quality, or in the development of new industries. The educational value of the Bureau's work in this respect seems to be very little understood by manufacturers, although recently the Bureau has received hundreds of letters, as well as many personal visits from manufacturers, seeking information as to standards of measurement, how to use them, how to measure the properties of materials, or as to the fundamental physical and chemical principles involved; also, what is of even greater importance, how to initiate and carry out scientific investigations and tests on their own account in their particular fields of work.

Institutions Abroad Similar to the Bureau of Standards

The importance of maintaining scientific institutions having to do with standardization and the application of precise measurements to the industries has been recognized by all the leading countries of the world. Great Britain maintains the Standards Department of the Board of Trade; also the National Physical Laboratory, whose functions include matters pertaining to scientific and technical standards, physical constants, and to some extent the properties of materials. The Laboratoire d'Essais of France, while not as extensive as the English institution, is charged with similar duties. Germany maintains three such institutions—the Normal-Eichungs Kommission, equipped with the buildings, personnel, and apparatus necessary in standardizing and controlling the weights and measures of trade; the Physikalisch-Technische Reichsanstalt, covering testing and investigations in connection with scientific and technical standards other than weights and measures; and the Prussian Government maintains the Materialprüfungsamt, a large institution devoted to the investigating and testing of structural, engineering, and

other materials. It is generally recognized that these institutions have been exceedingly important factors in the industrial progress of these countries.

Cooperation between Bureau of Standards and the Industries

While the greater part of the Bureau's efforts were given up during the war to work in connection with the military departments of the Government, it was never before called upon to such an extent for advice and scientific data by the industries. Most of these questions arose out of the manufacture of war material. A great many of these requests came directly from the manufacturers, others through the War Industries' Board, and still others from various commissions having to do with the war material production.

Every section of the Bureau cooperated to a greater or lesser extent with the manufacturers of the country, and, as a result, closer relations have been established between the industrial plants and the Bureau. It is evident that this relationship will continue and become of great economic value; but, if the Bureau is to retain its high position in the various industrial fields and meet the rapidly increasing demands for its services, the greatest amount of support possible must, of course, be given to it by the industries.

Fig. 1. Metallurgical Laboratory of the Bureau of Standards in which Part of the Gage Testing is being done

Training of Experts in Various Industrial Fields

Through the increased activities of nearly all the industries of the country and the demand for trained investigators, the Bureau's scientific staff has been largely depleted, and it will be a matter of some time before it can be brought back to the plane of high efficiency which it has previously maintained. It is assumed that the compensation paid scientific and technical men in the Government service will be adjusted to a scale more commensurate with that paid by scientific institutions and industrial laboratories, but even then the industries should cooperate in every way possible to maintain the Bureau's staff intact. Many instances could be given where the industries have taken experts with little warning and with no apparent consideration as to the consequences. The training of men for research is one of the most important ways in which the Bureau can aid the industries; but to do this it must keep its own staff in the highest degree of efficiency.

Organization of the Bureau of Standards

The organization of the scientific and technical staff is based on the nature of the expert service involved rather than on the classes of standards. For example, the division of weights and measures has to do with all matters pertaining to standards of length, weight, time, density, and similar questions, whether they arise in connection with the precision standards used in scientific investigation, the master standards of manufacturers, or the ordinary weights and measures of trade. A standard of quality or performance where any of the above measurements form the fundamental and most important factor would be referred to this division.

The division of heat and thermometry has to do with heat standards, the testing of heat-measuring apparatus, the determination of heat constants, of which there are many, and all investigations pertaining to quality or performance where heat measurement is the essential and predominating factor.

The electrical division is concerned with all the electrical problems that may be taken up at the Bureau, whether in connection with the various electrical standards of measurement, electrical constants, the electrical properties of materials, or the performance of electrical equipment.

Questions in optics enter into standards of all kinds to a greater extent than has been supposed; hence, there is an optical division with experts in spectroscopy, polarimetry, color measurement, the principles of optical instruments, and the measurement of the optical properties of materials.

Practically all investigations concerning the various classes of standards involve chemistry in one form or another. There are also many chemical standards and questions which arise in connection with chemical work generally, especially in the industries; hence, there is a chemical division, cooperating with every other division of the Bureau, as well as taking care of the questions of a purely chemical nature that fall within its regular functions.

The work of the structural engineering and miscellaneous materials division includes investigating, testing, and preparing specifications for these materials, such as the metals and their alloys, stone, cement, concrete, lime, the clay products, paints, oils, paper, textiles, rubber, and miscellaneous classes of materials.

The division of engineering research makes investigations and tests regarding the performance and efficiency of such instruments, devices, or machinery as the Bureau may take up that do not fall directly under one of the scientific divisions. The questions pertaining to the manufacture, specifications, testing, and use of the metals and their alloys is so important that a division known as the metallurgical division was formed of the experts engaged in these problems.

Gage-testing Section

One of the most important sections of the work of the Bureau of Standards, as far as the mechanical industries are concerned, is the gage department. The gage section was organized as a part of the division of weights and measures at the beginning of the war, to provide facilities on a larger scale to inspect and certify limit gages and precision length standards, and to assist in the solution of problems in connection with gage work. The staff of the section numbered about 140 on July 1, 1918, and had further increased to 225 in November of the same year. By July 1, 1919, the number had been gradually reduced to 55 members.

Scope of Work in Gage-testing Section

Besides the routine testing of gages at the Bureau in Washington, the section during the past year conducted three branch laboratories; developed and manufactured Hoke precision gages; improved, designed, and constructed gage-testing apparatus; salvaged and manufactured limit gages; stored, shipped, and conducted a clearing house for master gages; conducted instruction courses for government gage inspectors; studied gage and tolerance problems for the

National Screw Thread Commission; and prepared and distributed communications and reports regarding such parts of the work as are of general interest.

From July, 1918, to June, 1919, altogether 40,630 gages were tested. Of these 45 per cent were screw thread gages, 45 per cent were plain gages, and 10 per cent were profile and miscellaneous type gages. During the war this testing work was handled in such a way that the average time between the date of arrival and the completion of the tests and shipment back to the owner, was from three to four days.

Branch Gage-testing Laboratories

The three branch gage-testing laboratories maintained during the war were located in New York City; Cleveland, Ohio; and Bridgeport, Conn. Each was equipped with facilities duplicating on a small scale the Washington laboratory. These branches served a large number of manufacturers in the industrial centers in which they were located and aided gage production materially by making it possible for manufacturers to send sample gages and work by messenger for immediate inspection. All of the branch gage laboratories thus established have been discontinued on account of lack of funds.

Development and Manufacture of Precision End Standards

In July, 1918, experimental work was begun to demonstrate the feasibility of mechanical production of precision end gages under the direction of the inventor, W. E. Hoke, and in cooperation with the Bureau's experts in optical methods of measurement, which are essential. An early set of samples of equal length within 0.000002 inch, flat within 0.000004 inch, and within 0.000008 inch of the desired size has proved the practicability of the method. Upon receipt of this report the Ordnance Department made an allotment to cover manufacturing cost and commissioned the inventor. Machinery and special apparatus purchased under the allotment was installed and manufacture begun. By the close of the year more than 3500 gages had been manufactured, accurate within 0.000005 inch, and assembled in sets, the total value of which, compared with the price of the formerly imported gages, exceeded the amount of the allotment. The cost of experimental work and all machinery purchased was virtually saved in the first year's production.

Gage Salvage and Manufacture

During the year, 487 new master and inspection gages were manufactured, and 962 additional obsolete gages were salvaged for the Ordnance Department to conform to revisions in design. This was done as exigency work in the gage shop only when serious delay would result from the regular method of procuring gages from outside manufacturers, or when a small amount of work would salvage obsolete gages and save the expense of contracting for entirely new gages. Five additional lead testers were manufactured for the Ordnance Department during the past year, so that one machine has now been supplied for each of the principal arsenals.

Design and Construction of Gage-testing Apparatus

The following new designs of gage-testing apparatus have been made to embody the results of experimental work: Simplified projection lantern of short range with horizontal projection, ground-glass screen, and equipped with incandescent arc illumination; an improved and simplified balanced micrometer to be used for pitch-diameter measurements of thread gages by the three-wire method; a mechanical indicator to replace the optical lever system on the Bureau's lead-testing machines; apparatus for the measurement of periodic lead errors in plug thread gages; and a device for standardization of wire measurements. Apparatus and instruments are under construction at the present time for all of these designs. In addition to this work, the shop has built during the past year practically all of the special apparatus that was required for use in the Washington laboratory and in the branches.

Research Work Carried on by the Bureau

Research work has been carried out largely in connection with problems of the National Screw Thread Commission. Experiments have been made to determine suitable tolerances, allowances, and interference values for various classes of fits. Study has been made of methods of manufacturing taps and screw thread gages, together with the effect of errors in taps on the size and character of tapped holes. Proposed tolerance systems have been worked out, tabulated, and charted. Questionnaires have been prepared and issued, through which information has been secured from manufacturers and users of screw thread products relating to current practices. The replies that have been received have been studied, classified, and tabulated.

Fig. 2. New Industrial Research Laboratory of the Bureau of Standards at Washington

A large amount of valuable data have been collected relating to all phases of gage work. From this recorded experience it has been possible to advise manufacturers on a great many subjects relating to the proper design, inspection, and use of limit gages. This work is being continued and will be supplemented by literature prepared and distributed in such a manner as to reach and benefit the largest number of manufacturers. Standardization, research, routine testing of commercial gages and standards, and development of measuring apparatus will form important parts of the future work of the gage section.

Other Interesting Tests of Value in the Mechanical Industries

A carefully planned series of tests intended to demonstrate the economy and efficiency of oxy-acetylene welding and cutting apparatus is being made at the present time. Apparatus from the leading manufacturers in this line have been received for test. These tests are planned to show the conditions under which back-firing occurs, the characteristics of regulators under varying tank pressures, the economy of the apparatus in welding and cutting operations on material of various thickness, and the durability of the apparatus and the ease with which repairs can be made in service. Tests on electric welds have also been made in connection with the work of the Welding Research Committee of the Emergency Fleet Corporation.

An interesting investigation has been made on the strength of wire rope, the results of which have been published in

the Bureau's Technologic Paper No. 121. On the subject of hardness testing some investigations have been made, and a Brinell hardness numeral table, correct to the second decimal place, has been compiled. This table gives the Brinell hardness numeral for each one-hundredth of a millimeter of diameter of indentation from 2 millimeters to 6.94 millimeters both for 500 and 3000 kilograms pressure. Copies of this table are obtainable from the Bureau upon application.

The metallurgical section has carried on an extensive research work. During the past year the experimental heat-treating plant has been enlarged, new furnaces having been installed and the pyrometer equipment for individual units changed to a central station control. A new method of making thermal analysis has been developed and various tests have been made upon the mechanical properties of heat-treated structural alloys and steel.

High-speed Steel Investigations

A study of high-speed steels is being made (1) to throw further light on their constitution and properties; (2) to develop a simpler method than now in use for determining the relative value of two steels as cutting media. The methods now in use include thermal analysis, whereby heating curves are taken on previously quenched samples, and hardness tests made after hardening and tempering at various temperatures. Cooperation from the steel makers is expected in this work.

The Bureau has had the opportunity of carrying out tests on several types of product, including cast high-speed cutting tools which in test have shown cutting properties equal to the best forged tools of similar composition. The extension on a large scale of the use of cast tools will result in great labor and material saving and in lowering the cost of working metals. Besides these performance tests an investigation has been in progress on the general problem of the constitution and theory of the much-discussed high-speed steel and its "red" hardness. Data on several of the physical properties and microstructure of this steel, as affected by various heat-treatments, have been collected, and seem to answer many of the questions involved.

Investigations of Gage Steels

An investigation of the most suitable steels and treatments for the manufacture of precision gages, resulting from work originally carried on for the War Department, is now in progress. The work includes determination and comparison of resistance to wear, permanence, resistance to corrosion, soundness, expansibility, and economy under varying thermal treatments. It is expected that this investigation will be completed during the present year.

Valuable experiments have also been made upon operating methods, acid-resisting alloys, corrosion of brass, and the strength of solder and soldered joints, as well as upon the treatment of pure nickel, and of light aluminum alloys.

Scope and Resources of the Bureau of Standards

During the fiscal year ending June 30, 1919, the total expenditures of the Bureau of Standards amounted to approximately $2,674,000. The staff of the Bureau comprised about 1150 employes, of which 201 held scientific positions, 52 were office assistants, 55 engaged in the operation of the plant and 33 in the construction, in addition to 800 employes engaged in research and investigations, specially authorized by Congress. At the present the personnel consists of over 1000 regularly appointed employes as compared with approximately 500 prior to the war.

During the fiscal year ending June 30, 1919, the Bureau carried out 124,668 tests, of which 110,468 were for the Government and 14,200 for individuals. Of these tests nearly 10,000 were length measures, over 22,500 were physical and mechanical tests, and nearly 20,000 were temperature tests, while the remainder were distributed between engineering materials, structural materials, paper and textile industrial tests, metallurgical tests, aeronautical instruments, electrical, hydrometry, and optical tests, etc. Not less than 53 publications were issued by the Bureau, of which 36 were new and 15 were revised editions.

The laboratories of the Bureau of Standards are located in the northwest section of Washington on Pierce Mill Road, near Connecticut Avenue, and are reached by the Chevy Chase car line. They were located outside of the business center of Washington in order to insure freedom from mechanical, electrical, and other disturbances common to the business and more thickly populated sections of the city. Furthermore, the amount of ground necessary precluded a site near the city. It has been found by experience that the efficiency of the employes, especially those engaged in testing and scientific investigation, has been greatly increased by the location of the laboratories in a section free from the ordinary disturbances of city life.

* * *

TECHNICAL SCHOOLS MAY NOW BUY GOVERNMENT MACHINE TOOLS

The director of sales of the War Department announces that acting under the provisions of the Act passed by Congress known as the Caldwell Bill, plans have been completed for the sale of machine tools to educational institutions of recognized standing, at a price equivalent to 15 per cent of the original cost to the Government. School authorities who wish to purchase equipment under this act, will be requested to fill out a questionnaire from which will be determined the eligibility of the institution which they represent. This questionnaire must be submitted to the director of sales, War Department, Washington, D. C.

The director of sales will then pass upon the eligibility of the institution, and such institutions as are found eligible to make purchases will be supplied with purchasing coupons for the number of machines allotted to them, each coupon being good for the purchase of one machine. The various bureaus of the War Department having surplus machine tools for sale will also be directed to place the name of the educational institution on the mailing list for such machine tool bulletins as are issued from time to time. From these bulletins the educational authorities will be able to select machines to meet their requirements and can then negotiate directly with the office publishing the bulletin from which the machine is obtainable.

Under this plan, no preference will be given to either commercial organizations or educational institutions, and orders from either source will be considered on the same footing. Owing to the limited number of machine tools suitable for the purposes of educational institutions, however, all offices will be instructed to grant to educational institutions an option of ten days, from date of receipt of request to purchase a specific tool, in which to complete the details of inspection and purchase. Upon receipt of notice that the selected machine tools are available for sale, school authorities will forward shipping instructions, certified check for the amount of the purchase price, and one coupon for each machine bought. Freight charges will be paid by the purchasing institutions. School authorities desiring information relative to terms of sale under the "Caldwell Bill" should first write to the Director of Sales, Munitions Building, Washington, D. C. for questionnaire blanks. It has been announced that educational institutions in Ohio and Michigan lead among those who have filed questionnaires with the War Department as a first step toward securing surplus machine tools for their institutions.

* * *

Announcement has been made of the intention of the Australian Government to create an industrial court for the Australian Commonwealth, which will deal with labor disputes exclusively. The court will have power to legalize industrial agreements, and will be the final industrial court of appeal.

American Machine Tool Trade Abroad

THE exports of metal-working machinery from the United States during the month of November, figures covering which have just been made public by the Department of Commerce, show a slight decrease as compared with the exports during October. The total of the October exports amounted to over $5,000,000, while the total of the November exports amounted to slightly over $4,500,000. There is no perceptible decline in the exports of machine tools, however, the main decline being in metal-working machinery other than machine tools; but there is a very marked change in the destination of the machine tool exports. While, in October, France was the leader in imports of machine tools from the United States, taking a total of $570,000, the November imports amounted only to about $390,000. The exports to England, which were not quite $500,000 in October, rose to nearly $700,000 in November. Belgian imports of machine tools amounted to nearly $150,000, while Canada imported machine tools to a value of over $350,000, representing next to England and France, our largest customer.

EXPORTS OF METAL-WORKING MACHINERY FROM THE UNITED STATES, NOVEMBER, 1919

Countries	Lathes, Dollars	Sharpening and Grinding Machines, Dollars	Other Machine Tools, Dollars	All Other Metal-Working Machinery, Dollars
Belgium	129,837	6,924	8,305	69,351
Denmark	7,033	1,064	9,080	28,632
Finland	......	......	......	14,955
France	136,830	112,555	143,968	1,021,842
Gibraltar	......	......	......	4,000
Greece	......	......	1,073	72
Italy	945	17,500	53,772	42,096
Netherlands	13,862	......	11,808	20,639
Norway	717	1,846	1,062	5,502
Portugal	......	......	......	2,555
Spain	38,056	3,548	11,131	11,995
Sweden	19,421	9,974	2,212	24,827
Switzerland	125	706	324	2,450
Turkey in Europe	441	......	......	......
England	112,499	163,396	414,043	550,841
Scotland	......	......	403	2,815
Ireland	......	......	1,336	......
Canada	61,118	88,125	196,592	210,240
Costa Rica	1,665	......	......	70
Guatemala	......	138	56	569
Honduras	......	......	......	88
Nicaragua	......	......	450	183
Panama	......	......	335	......
Salvador	......	......	74	......
Mexico	4,666	419	8,716	22,066
Newfoundland and Labrador	......	......	221	......
Jamaica	1,581	......	138	625
Trinidad and Tobago	48	6	291	......
Other British West Indies	903	......	......	......
Cuba	16,276	400	49,274	24,567
Danish West Indies	......	......	64	......
French West Indies	1,164	......	42	......
Haiti	......	100	......	37
Dominican Republic	842	......	57	486
Argentina	5,504	5,857	11,685	18,711
Bolivia	......	......	22	......
Brazil	4,808	1,234	7,583	4,381
Chili	700	583	2,790	75,206
Colombia	......	295	833	576
Ecuador	......	......	148	......
British Guiana	242	......	......	......
Dutch Guiana	......	58	......	......
French Guiana	......	180	30	......
Peru	2,754	18	2,393	11,009
Uruguay	3,175	......	1,199	657
Venezuela	6,900	142	......	300
China	3,585	520	2,081	11,592
British India	3,443	255	5,121	8,223
Straits Settlements	......	......	4,319	......
Dutch East Indies	16,804	2,125	1,311	12,740
Hongkong	......	......	40	3,890
Japan	21,404	12,182	31,075	190,342
Russia in Asia	......	......	586	4,456
Australia	1,776	2,326	9,146	9,457
New Zealand	8,683	504	1,960	2,776
French Oceania	......	......	......	17
Philippine Islands	10,616	764	8,106	16,027
Belgian Kongo	......	......	......	1,382
British West Africa	960	......	......	......
British South Africa	8,418	5,235	1,289	16,453
French Africa	......	......	......	1,669
Portuguese Africa	......	......	......	1,354
Total	647,801	438,979	1,006,544	2,452,721

Machinery

Present State of the Foreign Machine Tool Trade

Interviews with a number of machine tool builders and manufacturers of small tools on the present conditions in the foreign trade, have made it possible for MACHINERY to present a general review of the problems that now face the American machine tool industry. Reports from machine tool builders indicate that while during the last few months they have made deliveries on orders entered at an earlier date, and therefore shipped an appreciable amount of machine tools abroad, new orders are not coming in to the same extent as had been expected, due, mainly, if not entirely, to the abnormal foreign exchange rates. Some manufacturers have been able to sell to Belgium in spite of the low value of Belgian money, because Belgium must have machine tools irrespective of cost; the trade with France has been appreciably curtailed, while the trade with Great Britain has suffered less, due, of course, to the fact that the exchange rates are not as abnormal in the case of the United Kingdom as they are in the case of France or Belgium. The Italian lira is now worth less than the franc, and hence trade with Italy is still more difficult.

In the case of precision instruments, for example, where formerly some manufacturers sent nearly half of their output abroad, their foreign trade has been cut to from ten to fifteen per cent; and similar reports are given by manufacturers of certain lines of machine tools where the domestic European competition comes into play and is enabled to exclude the American tools. Trade in small tools, such as taps and drills, etc., has remained fairly normal until recently, but even in these lines there has been an appreciable decline.

On the other hand, there are certain lines of American machine tools which can always be sold in Europe, no matter what the exchange rates, because these lines are not made abroad and manufacturers there must buy them at any price. These machines include especially the more highly developed and special machinery in the grinding, milling, and automatic machine lines.

Proposals Made for Stimulating Foreign Trade

It is futile to expect that the exchange rates can be brought back to normal by artificial means. Loans extended by the United States will remedy the conditions only temporarily, and in the end, the condition which it was intended to remedy will only be aggravated, unless the European countries begin to produce on a large scale so that they can export goods to the United States and thereby build up a balance that will tend to equalize the exchange. Even the bankers, who ought to be best informed on a subject of this kind, state that it is impossible to foretell when the European exchange rates will return to normal, and they also state that it is likely that the exchange rates with some of the European countries will fall still more before they will again begin to rise. Some American manufacturers have allowed some of their foreign customers a special discount, aimed to partially or wholly make up for the difference in exchange. Others have made arrangements to allow longer credits than usual, and still others have agreed with their customers to have the purchase price deposited in foreign money, based on nearly normal exchange rates, in the banks of the country where the sale is made, the money remaining at this bank at a nominal percentage of interest until such time as exchange rates will again become more nearly normal, so that it will be advisable to have the money transferred to the United States.

In discussing these various plans with one of the firms that has always been one of the leaders in the foreign trade

of machine tools, it was pointed out that while discounts doubtless would tend to stimulate the trade, it would be necessary for the American manufacturer to carefully consider the effect of any policies now adopted upon their future dealings abroad. Trade customs are often inaugurated by making some special allowance intended to be in effect only temporarily, and every machine tool builder should carefully consider what effect any steps taken today will have upon his trade and business dealings abroad three or five years from now. Furthermore, it is highly important to ascertain if any discounts thus made will benefit the ultimate buyer or consumer of the machinery or tools, and not merely the dealer. Unless the discount allowed actually benefits the ultimate costumer, nothing has really been gained by allowing such a discount.

When considering the question of extending longer credits, it should be remembered that on account of the higher prices of materials and labor at the present time, the capital required to keep a manufacturing establishment going with the same amount of production as formerly is much greater than in the past; hence, the American manufacturer needs all the capital that he can obtain in his own business. He is, therefore, not in a position to extend long credits, permitting his customers to make use of the money which he himself requires for the conduct of his own business. At best, the extension of credit would mean only a few months more than ordinarily, and with the uncertainty as to when exchange rates will come back to normal, it is doubtful if a few months' extension of credit would be of any practical value. Instead, it has been pointed out that the use of trade acceptances by foreign buyers, especially dealers, drawn upon their financial representatives in the United States, would be one of the best solutions, and would be helpful to seller and buyer alike.

As already mentioned, some foreign dealers have requested American manufacturers to grant them the privilege of depositing the purchase money, based on nearly normal exchange rate, in a bank in their own country, with the idea that the money could be held there at a low percentage of interest until the exchange rates become normal. In one instance, the account thus created in favor of the American manufacturer carries four per cent interest. It is evident that in cases of this kind the American manufacturer takes all the risk. He is deprived of the use of his money for a long period, gets but a small percentage of interest on it, and has no assurance that the exchange rates will return to normal soon enough to make it worth while for him to keep his money abroad, awaiting a rise in exchange.

Foreign Loans Placed in the United States

The Belgian loan for \$25,000,000 which was placed in the United States during the past month, will, of course, tend to aid in increasing the trade with that country. The United States Treasury Department has also just authorized the flotation in this country of an issue of \$25,000,000 in Italian bonds, which is the first installment of a complete issue of a \$100,000,000 loan, which is underwritten by a group of leading Italian bankers. These bonds are issued at par at an interest rate of 6½ per cent. Loans of this kind will, of course, temporarily, facilitate trade.

Opinions of Manufacturers

It is the opinion of those who have been long engaged in foreign trade and who have given the present situation very careful study, that of the various means proposed for stimulating the foreign trade, the special discount is the most feasible, providing the American manufacturer can definitely ascertain that the discount will accrue to the benefit of the ultimate consumer. It is pointed out, however, that every foreign country must be considered separately. In the first place, the difference in exchange rates in different countries is so marked that where a certain policy might be practicable and would stimulate trade in one country, it might be entirely impracticable in another. The problem is so involved that it is not possible to give any general rule as to the best way in which to handle it or to present any general solution of the problem. The American manufacturers, however, should be careful not to neglect their foreign trade connections at this time, even though sales may not be as large as usual. It is true that the domestic trade just now will absorb the output of most American machine tool builders, even if there were no foreign trade at all, but there has been no greater harm done to our foreign trade in the past than the policy of neglecting it whenever the domestic trade was booming. At the present time, on account of the difficult conditions in the foreign trade, there is a still greater temptation to neglect it. That tendency should be counteracted as far as possible, because the time will come when the foreign trade will provide a necessary outlet again for American machine tools, and whatever can be done at this difficult period to stimulate and foster that trade and to maintain the friendly relations with foreign customers, the more successful will that trade be in the future.

Summary of Important Points

The three cardinal points laid down by a machine tool manufacturer unusually well acquainted with the foreign trade, and which have been emphasized above, are as follows:

1. Any trade policies or practices adopted at the present time should be considered not only in the light of present conditions, but with a view to the future so that whatever practices or methods that are inaugurated today will not react unfavorably a few years hence.

2. American manufacturers must ascertain that any concessions or discounts which they may make in order to obtain foreign trade will benefit the ultimate user or buyer abroad.

3. While the conditions of foreign trade are unfavorable and those of domestic trade at the present time unusually promising, American manufacturers should not permit themselves to neglect their foreign trade connections, but should maintain their relations abroad to the fullest extent of their ability. Ultimately there will be a big opportunity for foreign trade, and the foundation for that trade will be laid at the present time in the face of unusual difficulties.

* * *

GOVERNMENT MACHINE TOOL SALES

In view of the criticism relating to the handling of the sales of government machine tools published last month in MACHINERY, it is of interest to note the following expressions of appreciation of the manner in which other offices have handled their sales, authority for publication of which has been given by the War Department through the office of the Director of Sales. In a letter by D. C. Selheimer, factory manager of the LaFayette Motors Co., Indianapolis, Ind., the statement is made that in addition to machines recently acquired, "all previous machines purchased from the Government have been received in good condition. We wish to take this opportunity to thank you for all past favors to us in the matter of securing machinery and to assure you that we fully appreciate your efforts." The machines referred to were secured from the Ordnance Salvage Board through the district office at Cleveland. The previous machine tools referred to consisted of 41 machines, the total value of the machines bought by the LaFayette Motors Co. being nearly \$42,000.

W. G. Morse, factory manager for the Austin Mfg. Co., also speaks of the satisfactory service rendered by the Government in a letter to the office of the Director of Sales. He says: "I am pleased to advise that in all cases all of the machinery purchased was received here in first-class condition, properly packed and properly slushed, and I wish to thank you and the other men whom I met in connection with this proposition, for their interest and courtesy which they displayed in all of our dealings."

Special Types of Drilling Machines

By F. E. JOHNSON

A PREDETERMINED fixed rate of feed for a drill is a factor that will often assist in obtaining the maximum output of work and in reducing costs for broken drills. Piece-work operators are likely to force the drills in order to make as much money as possible if the feed and the tool are not automatically controlled. A fixed automatic quick-approach and feed combined with an automatic quick-return for the drill spindle or spindle head, after the hole has been completed, is a feature which, if applied to the operating principle of the machine, will greatly reduce the non-productive time per machine, particularly if the operator handles more than one machine or a single machine of the multiple-spindle type.

This operating principle as applied to a certain standard type of machine is illustrated in Fig. 1. The illustration shows only those particular features that are to be discussed here. The machine is of the semi-automatic horizontal multiple-spindle type, and is especially designed for drilling several pieces of work in which but one hole is required. Five duplicate holding jigs provided with the necessary means for guiding the drill are bolted to the seats *A* in alignment with the drill spindles. The feed for the spindles is obtained through the cams *B*, one cam being provided for each spindle. The tail end of each spindle is secured to a slide which is provided with a projecting lug carrying a roller that bears against the periphery of the cam. During the period that the drill is feeding into the work, the spring *C* (contained in the slide) is compressed through the action of the cam against plunger *D*. At the completion of the drilling operation, the high point on the periphery of the cam is in contact with the roller. As the cam continues to revolve this spring is released, resulting in the drill being quickly withdrawn from the work. The design of the cam is such as to allow the spindle to remain at rest long enough for the operator to unload and load the jig. The cams are so timed in relation to each other that they operate the spindle feeds in rotative order. The camshaft *E* is driven by a worm and worm-wheel, the details of which are not shown in the illustration. The rotation of the drill spindles is obtained by means of spiral gearing. The driving gear-shaft *F*, as well as the camshaft, is continuously in motion during the operation of the machine. The advantage obtained by the arrangement described is that the operator's time is entirely consumed in loading and unloading the jigs.

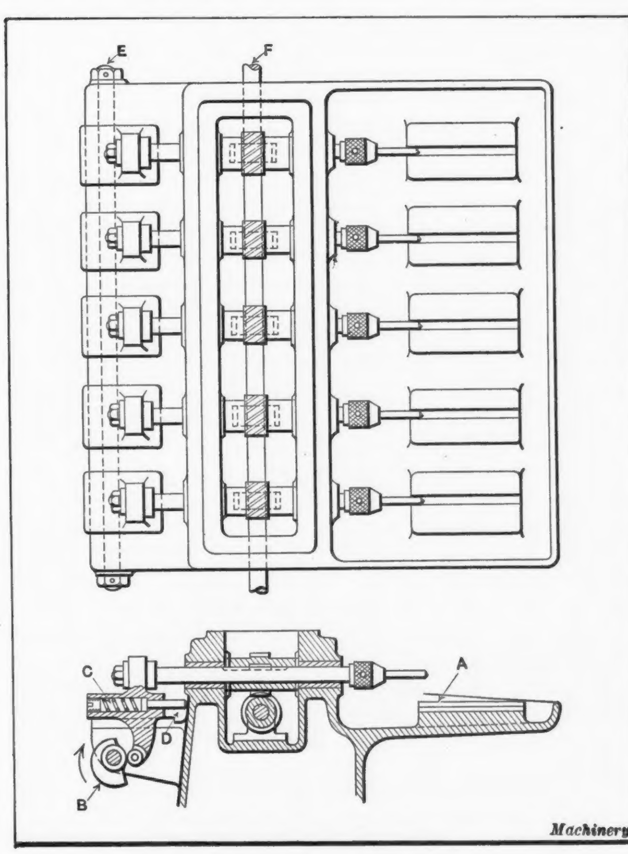


Fig. 1. Multiple-spindle Horizontal Drilling Machine with Cam-controlled Quick-return Feed

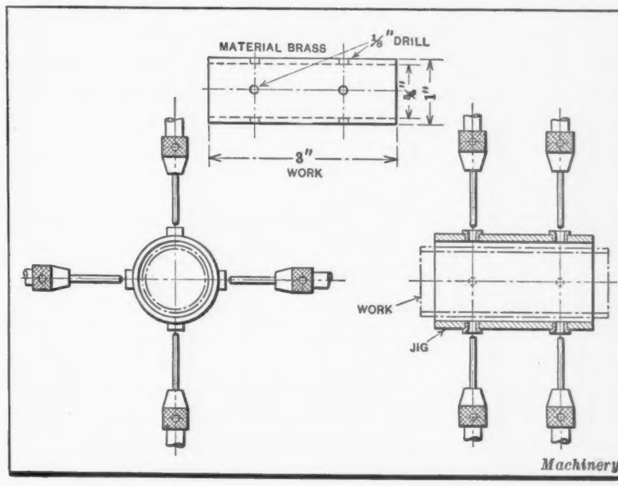


Fig. 2. Spindle Arrangement for Hand-feed Machine designed for simultaneously drilling Eight Holes in a Brass Sleeve

Hand-feed Drilling Machines for Production Work

For certain classes of work, a machine of the hand-feed type may be less expensive to design and build than one of the semi-automatic or automatic type and the results obtained may be wholly satisfactory. This fact can be best illustrated by referring to Fig. 2 in which are shown a brass sleeve with eight 1/8-inch holes drilled in it, and a special spindle arrangement by means of which the holes are drilled simultaneously. The feed required for the drill is 3/16 inch, which allows 1/16 inch for the drill point. The thickness of the bushing wall is 1/8 inch, and the time required to drill through the wall, at a spindle speed of 2600 revolutions per minute and a feed of 0.002 inch per revolution, is approximately 2 1/4 seconds.

A semi-automatic machine, or one equipped with an automatic feed in combination with a hand-operated jig, would not be of advantage for producing this class of work, because so little time is consumed in the actual performance of the operation. The time required to perform an operation, in conjunction with the quantity of work required, is a factor which must be given consideration in designing a machine. If a large output of sleeves is required, a full automatic machine equipped with a magazine feed and with provision for automatically clamping, drilling, and ejecting the work can be employed to advantage. One operator is able to handle a number of machines of this type, as his duties consist principally in keeping the magazines supplied. It is obvious that the full automatic drilling machine can generally be employed only for producing small light parts.

Advantages of the Semi-automatic Machine for Special Work

The time required for a semi-automatic machine to perform the work required of it will in many cases allow the

operator to handle conveniently more than one machine at a time. Fig. 3 illustrates a common type of special semi-automatic multiple-spindle machine of the horizontal type used on quantity production work for small- and medium-sized cast-iron and brass parts. The work to be drilled is shown at *B* in the upper right-hand corner of the illustration. The frame of the machine supports the camshaft upon which two cams *C* and *D* are mounted. The paths on these cams are designed to produce right- and left-hand traverse of the opposed spindle slides. The camshaft is driven by a worm and worm-wheel as shown. The jig for holding the work is attached centrally between the two spindle slides. The drill spindles are driven by the shaft *A* which carries two wide-faced gears for driving the spindles in each head.

The quick-return or back-throw function is accomplished by the 45-degree path shown in the cam development diagram. The sides *E* and *F* of the respective cams *C* and *D* force the roller studs attached to the slides quickly to the right or left, as the case may be, when the rotation of the cams brings the rollers in contact at points *a*. Cam angles greater than 45 degrees would not be practicable in this instance. The automatic quick-return could be accomplished in one second if the drill slides were operated against spring pressure. The weight of a body that is to be moved is a factor that must be considered when employing springs for functions that are similar to those required in the case under consideration.

In certain instances where this type of cam is used, it

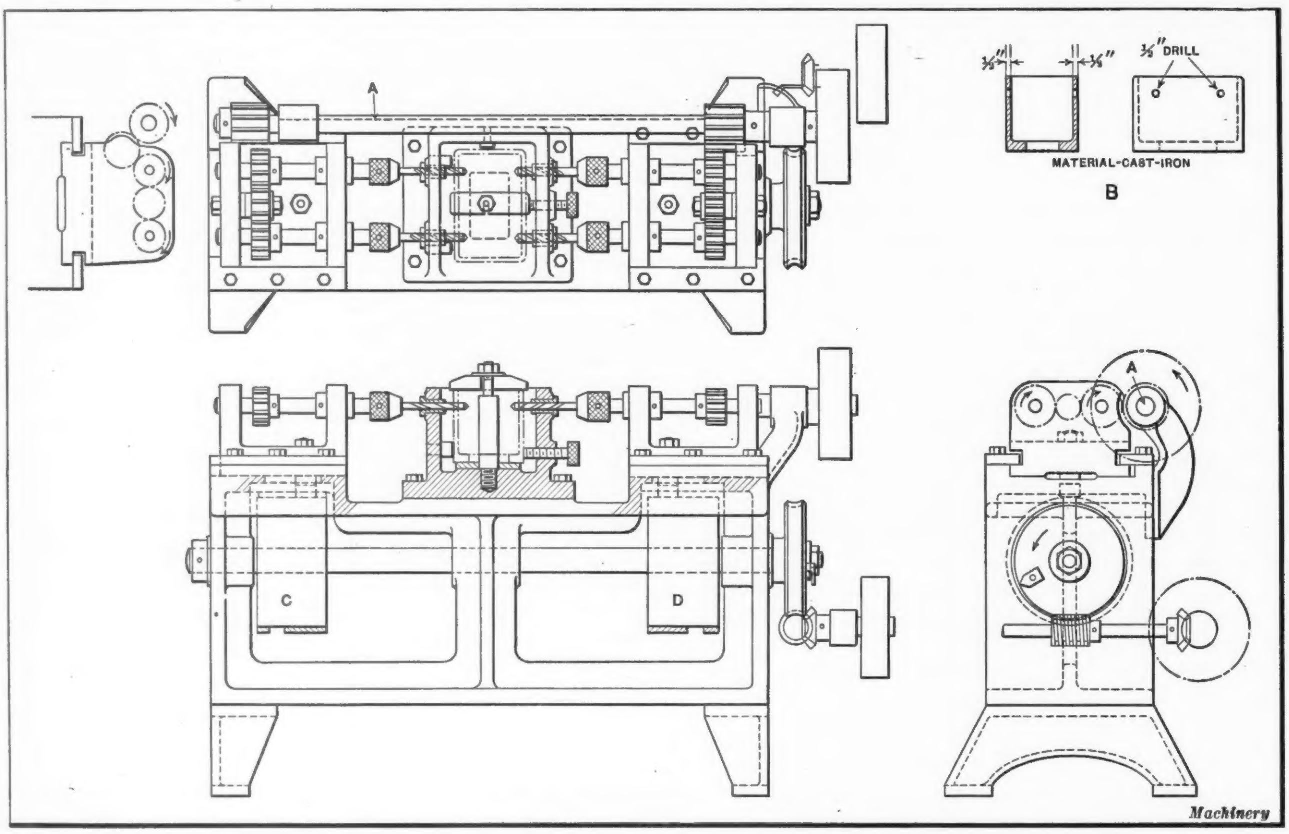


Fig. 3. Special Opposed-spindle Horizontal Drilling Machine, with Cam-operated Tool-slides and Centrally Located Holding Jig

will be found necessary to add a variable-speed or planetary gear arrangement to the camshaft drive in order to accomplish the quick-return of the slide in a reasonable length of time. The diameter of the cam-drum and the length of the back-throw movement are factors which may increase the time consumed in the back-throw movement, if a variable-speed arrangement is not employed. Where the operation of a machine is to an extent dependent upon cam control, it is always advisable to make a preliminary diagram by laying out a development of the cam surface. If this precaution is not adhered to, mistakes in first judgment may make extensive and costly changes necessary after the work has been in progress a considerable length of time. The use of cams offers a convenient method for imparting motions to slides and other such members of a machine. It is good practice to advance the drill slowly if it enters the work at an angle, and then to accelerate the feed after it has been well started. For deep-hole drilling, choking of the drill by chips may be prevented by withdrawing the drill at intervals. An advantage obtained by means of cam-operated machines is that the individual cam may be readily designed to accomplish these features of operation.

The operator, after clamping the work in place, starts the feed for the drill slides either by throwing the worm into mesh with the worm-wheel or by some form of clutch mechanism. The time required for one revolution of the camshaft is the time consumed in performing the drilling operation and includes the quick-approach time and the time necessary to make the quick-return traverse after the work has been completed, if these features are necessary. With the completion of one cycle of the cams, a dog fixed to the worm-wheel comes into contact with some form of latch or tripping arrangement (provided, of course, that a drop-feed is employed) and drops the worm out of mesh with the worm-wheel. If a clutch is employed to rotate the worm-shaft, this dog will, of course, act upon the clutch instead of upon the tripping arrangement.

In this particular case, the drill-feed movement for the slides is ¾ inch; the drills run continuously within their guide bushings in the jig and operate at a speed of 500 revolutions per minute. The feed of the drills is 0.006 inch per revolution, and the time required for the drill-feed movement of the slides is about fifteen seconds. Approximately one second should be sufficient time for withdrawing the drills after the completion of the operation.

Reference to the cam diagrams, Fig. 4, shows that the actual feeding time allowed is 14¾ seconds and that 1¼ seconds is the quick-return allowance. This modification is the result of requirements developed in laying out the cams.

Types of Special Vertical Drilling Machines

Heavy-duty vertical-spindle drilling machines are designed, in principle, as shown at the left in Fig. 5. The proportions and general arrangement of the frame are designed to

resist the severe strains that result from driving large high-speed drills at their maximum capacity. The thrust exerted by the drill pressure upon the work-table is partly resisted by an adjusting screw of sufficient strength. A slight deflection of the table or frame is sufficient to create considerable friction upon the sides of the drill. In machining deep holes in tough materials, the result is that the drill sticks and binds so that excessive time and power are consumed in the performance of the operation. The feed for the drill spindle of the machine is obtained through a rack and pinion. The pinion is driven by a worm and worm-wheel and the rack is secured directly to the spindle, the pinion which operates it being small in diameter as compared with the size of the worm-wheel.

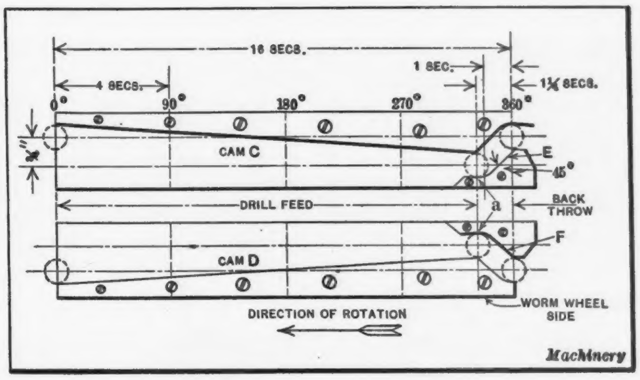


Fig. 4. Development Diagram for Cams used on the Machine shown in Fig. 3

The common arrangement for a cam-operated spindle head, where the drum type of cam is employed, is shown at the right in Fig. 5. The drill slide is operated by means of the cam E, which is mounted on the camshaft C and driven through worm A and worm-wheel B. The steel cam-straps D are bolted to the drum of the cam and are so formed as to produce the required traverse of slide F, through the medium of roller G. The various weak points in this design are the distance c of the drill spindle center from the base of the slide; the distance d that the worm-wheel is removed from the cam-drum; and the height of the roller stud and roller G, the combination of which offers only a single-point contact with the cam-straps.

The end thrust exerted in feeding a drill spindle contained in a slide has a tendency to lift the slide from the gibs. If distance c is excessive and if the end thrust from the drill feed is severe, great pressure is exerted on the gibs and face of the slide in an upward direction along line X-X. The result is that wear occurs rapidly and excessive power is consumed through friction of the parts. Severe end thrust from drills, if indirectly transmitted to the straps of a cam-drum, results in setting up torsional strains in the camshaft, provided the worm-wheel is considerably removed from the drum. The result is that smoothness of motion for the cam cannot be obtained. Unevenness of motion in the camshaft is magnified in the drum, increasing directly as the difference in the diameters of the drum and shaft increase. In cases where the load imposed upon a cam is considerable, it is good practice to attach the worm-wheel directly to the drum as shown in the partial sectional view at H. The forces applied are then, practically speaking, transmitted directly to the periphery of the cam. This drill-feed arrangement is suitable only for light and medium drilling operations, while the construction shown at the left in this illustration is more especially adapted for heavy drill-feeding pressures.

* * *

ACCIDENT PREVENTION IN STEEL INDUSTRY

The November number of the *Labor Review* of the United States Bureau of Labor Statistics states that, in spite of the war-time conditions and the high pressure under which the industries then worked, the iron and steel industry of the United States, considered as a unit, showed proportionately fewer accidents during the years 1915-1918 than were recorded for the period 1910-1914. This statement is true both as regards the frequency and the severity of the accidents. In other words, the exceedingly unfavorable conditions of the war period were not sufficient to overcome the results of the improved conditions in the industry resulting from the safety movement. Nevertheless, it has been pointed out that many of the accidents during the latter period were of the preventable kind, and that continued vigilance will still further reduce accidents is without question.

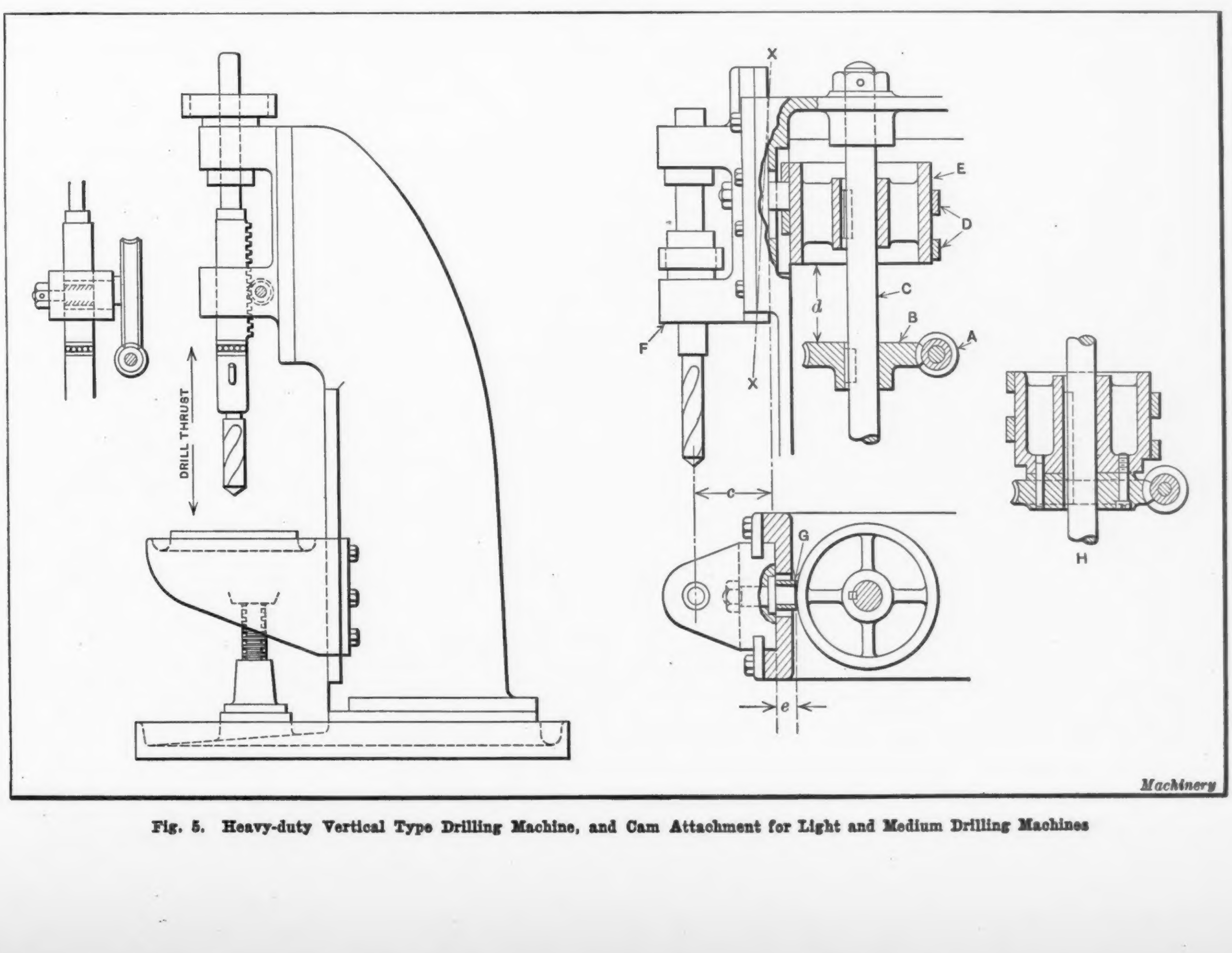


Fig. 5. Heavy-duty Vertical Type Drilling Machine, and Cam Attachment for Light and Medium Drilling Machines

Turret Lathe Practice

Typical Examples of Work Done on the Turret Lathe—Based upon the Practice of the Warner & Swasey Co., Cleveland, Ohio

THE present article showing examples of work machined on the Warner & Swasey turret lathes deals with chucking work on castings and forgings as well as with bar work. In each example, a lay-out of the tooling equipment is shown as well as halftone illustrations showing the machines set up for, or performing, the operations required. A detailed description of the various steps in each operation or chucking is also included. The actual time required for finishing the parts to be made from castings or forgings, including the time necessary to clamp or chuck the work and to remove it from the machine after the operations have been completed, is given, this being designated as "floor-to-floor" time. The time given for producing parts made from bar stock includes the time required for feeding the stock and for cutting off the finished part. The type of machine employed in each case, is given with each description of the operation. It will be noted that in the details of the castings dealt with, the surfaces finished by the operations described are indicated by heavy lines, so as to make them readily distinguishable. The letters on the detail drawing of each piece of work refer to the same surfaces as similar letters on the illustration showing the tool lay-out for that piece.

Tool Lay-out for Machining Piston Valve Followers

Fig. 1 shows a cast-iron piston valve follower which is finished in one chucking on a No. 3-A universal hollow hexagon turret lathe. A lay-out of the tools used in performing this operation is shown in Fig. 2. The operation consists of finishing surfaces *A*, *B*, *C*, *D*, *E*, and *F*, the sequence of the various steps in the operation being as follows: (1) The work is mounted on a three-jaw chuck equipped with special jaws that expand and hold the work in place by

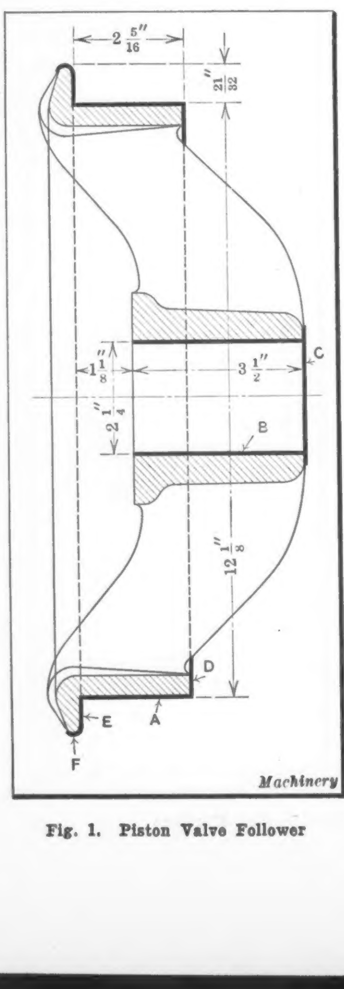


Fig. 1. Piston Valve Follower

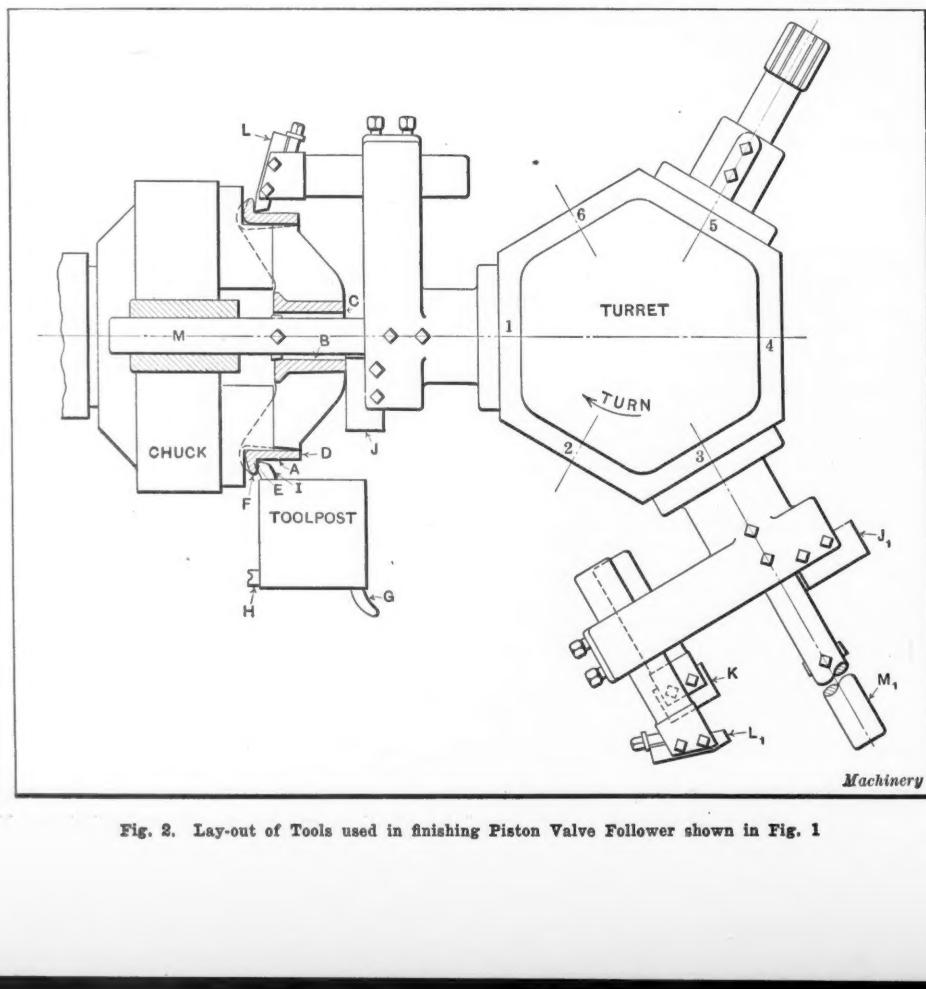


Fig. 2. Lay-out of Tools used in finishing Piston Valve Follower shown in Fig. 1

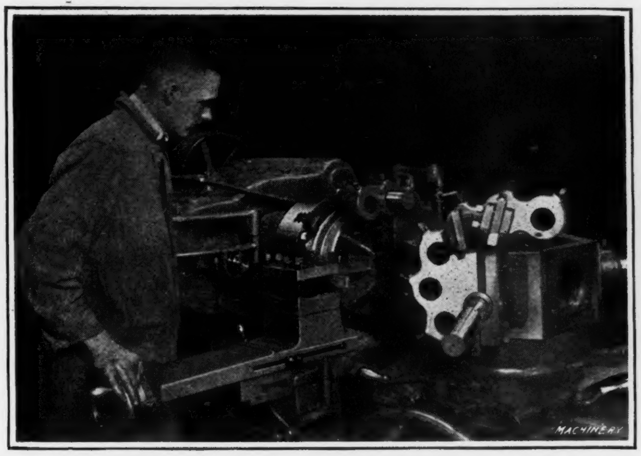


Fig. 3. Machine engaged in taking the Roughing Cuts on the Piston Valve Follower

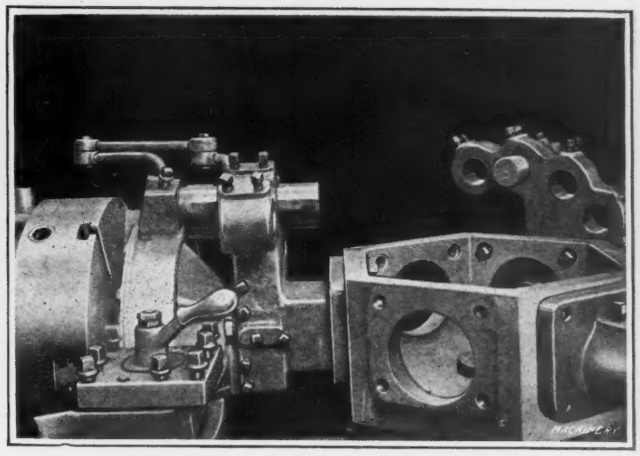


Fig. 4. Close View of Machine shown in Fig. 3, engaged in taking Finishing Cuts

exerting pressure on the inside of the rim. (2) Rim *A* is rough-turned by cutter *L*, which is held in an angle cutter-holder; hole *B* is rough-bored by the cutter held in boring-bar *M;* and hub *C* is rough-faced by cutter *J*, all of these tools being mounted on the turning and facing head which is held in Face 1 of the turret. At the same time, surfaces *D* and *E* are rough-faced by cutter *G*, and surface *F* is formed by cutter *H*, these cutters being held in the toolpost, which is generally known as the "square turret." (3) Rim *A* is finish-turned by cutter L_1 which is held in an angle cutter-holder; hole *B* is finish-bored by the cutter held in boring-bar M_1; surface *D* is finish-faced by cutter *K;* and hub *C* is finish-faced by cutter J_1; all of these cutters are mounted on the turning and facing head held in Face 3 of the turret. (4) Surface *E* is finish-faced by cutter *I* which is mounted in the square turret. (5) Hole *B* is reamed by the reamer mounted in Face 5 of the turret. The total time required for producing one piece of work is 8 minutes when the cutters are made of high-speed steel, and 4½ minutes when they are made of stellite. It will be noted that before the tools on the turning and facing heads commence taking cuts on the work, the pilot on the boring-bar of the head being used, enters into a guiding bushing as shown. Fig. 3 shows a machine engaged in performing the second step in the series, while Fig. 4 shows a machine engaged in performing the third step.

Valve Body Tooling Equipment

Four distinct operations are required to machine the valve body illustrated in Fig. 5, No. 3-A universal hollow hexagon turret lathes being used in each case. This piece of work is made of cast iron. The tool lay-out for the first chucking is shown in Fig. 6, while Fig. 7 shows a machine provided with the equipment for performing this operation. The order of the first operation, step by step, is as follows: (1) The work is first placed on the pilot bar mounted in Face 1 of the turret, Fig. 6, which is then indexed to the position shown in the illustration, after which the work is secured in fixture *W*. The purpose of the pilot bar is to enable the work to be readily placed in the fixture. (2) Holes *B*, *C*, and *D* are rough-bored by cutters mounted on boring-bar *E* which is held in the turning and facing head mounted in Face 2 of the turret, and surface *A* is rough-turned by tool *F* which is also held in this head. At the same time, flange *G* is rough-faced by cutter *H* which is mounted in the square turret. (3) The finish-boring operations on surfaces *B*, *C*, and *D* are performed by cutters mounted on boring-bar E_1; and the finish-turning of surface *A* is done by cutter F_1, this boring-bar and turning tool being held in the turning and facing head in Face 3 of the turret; at the same time, the finishing cut is taken on face *G* by means of cutter *J* in the square turret. (4) Surfaces *K* and *M* are rough-faced and *L* and *N* are rough-formed by a special "disappearing" tool mounted in Face 4 of the turret. (5) Surfaces *L* and *N* are finish-formed by another special disappearing tool mounted in Face 5 of the turret, this operation completing the work done in the first chucking.

A lay-out of the tooling equipment used in performing the second chucking on the valve body is illustrated in Fig. 9, while a machine provided with this equipment is shown in

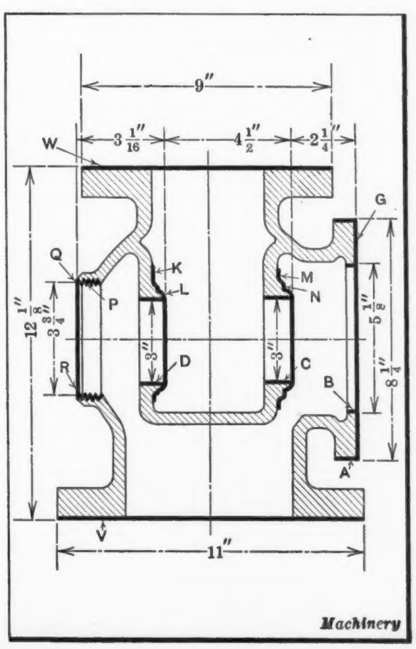


Fig. 5. Drawing of Valve Body

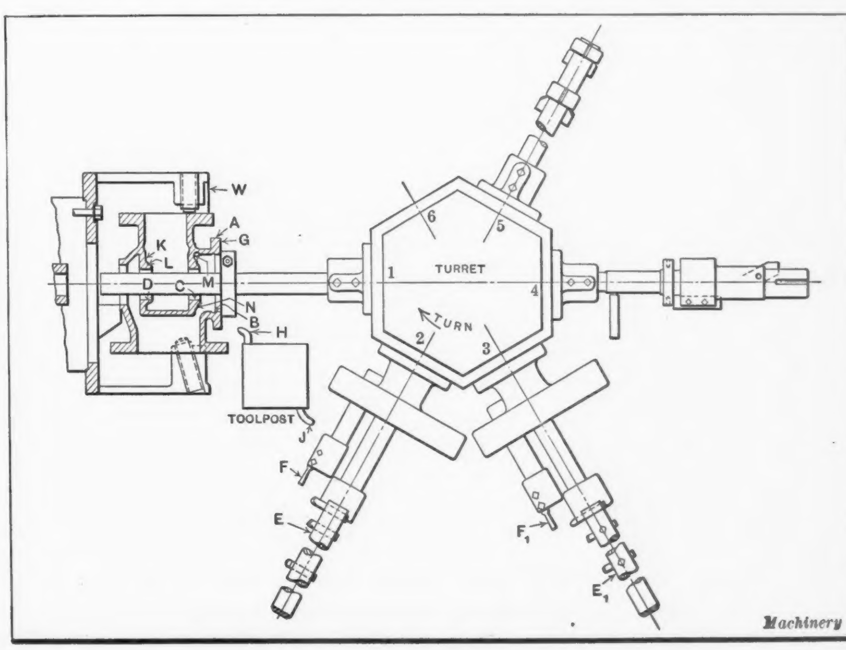


Fig. 6. Tooling Lay-out for First Chucking on Valve Body

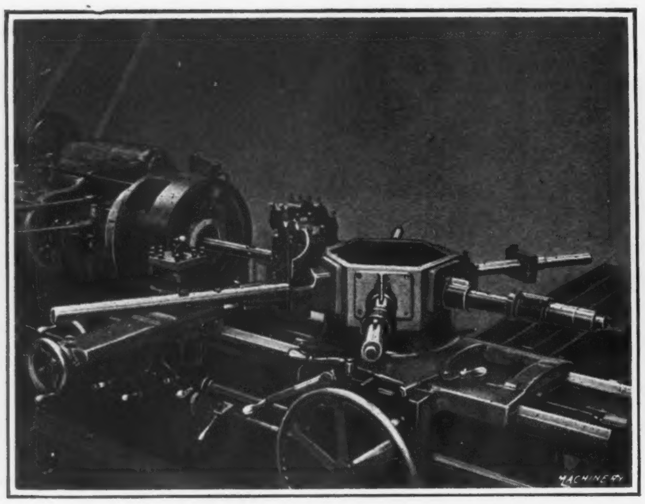


Fig. 7. Machine Set-up for performing the First Operation on the Valve Body

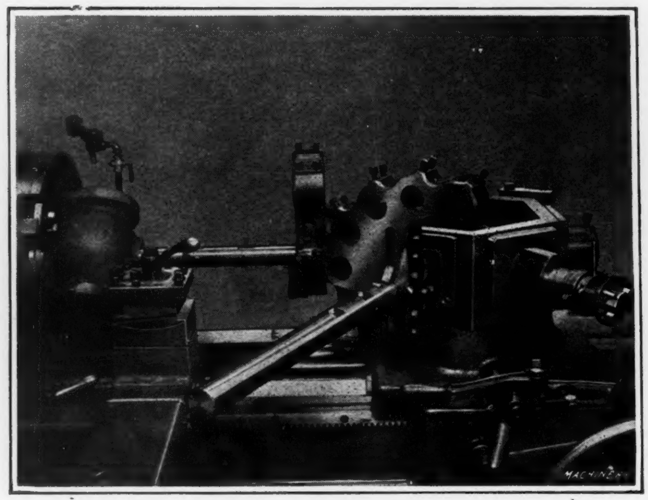


Fig. 8. Set-up of Machine for performing the Second Operation on the Valve Body

Fig. 8. The various steps of the operation are taken in the following order: (1) The work is mounted on the pilot bar in Face 1 of the turret, Fig. 9; then the turret is indexed to the position shown in the illustration, so that the work can be readily secured in fixture *O*. (2) Hole *P*, Fig. 5, is rough-bored by the cutter mounted in boring-bar *S*, and surface *Q* is rough-faced by cutter *T*, these tools being held in the turning and facing head mounted in Face 2 of the turret. (3) Hole *P* is finish-bored by the cutter mounted in boring-bar S_1; surface *Q* is finished-faced by cutter T_1; and bevel *R* is turned by cutter *U*, all of these tools being held in the turning and facing head in Face 3 of the turret. (4) Hole *P* is tapped by the tap mounted in Face 4 of the turret. In the third and fourth chuckings of the valve body, the roughing and finishing cuts are taken successively on flanges *V* and *W*, Fig. 5, by cutters held in the square turret, the work being held in a chuck having special jaws. There are no illustrations given of the tooling equipment used in performing these operations. The total time required to complete the four operations on one piece of work is 27 minutes.

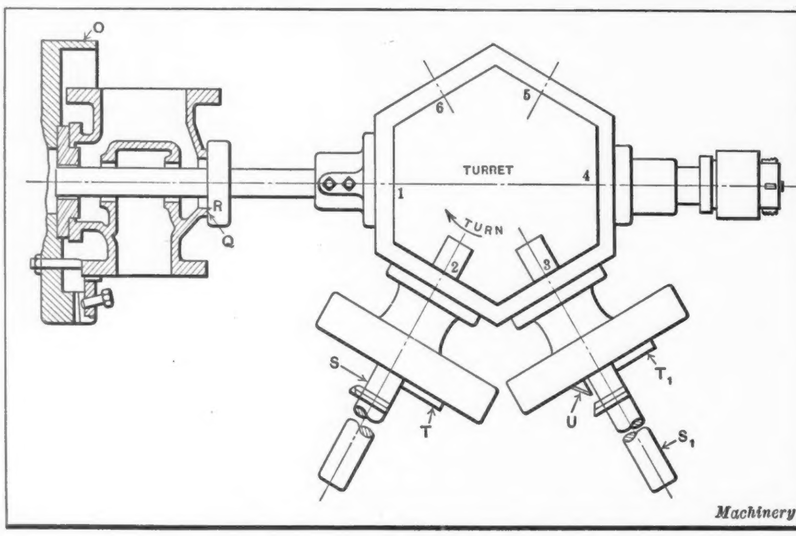


Fig. 9. Tooling Equipment used for Second Chucking on the Valve Body

Equipment Used in Finishing Spur Gears

Cast-iron spur gears of the type shown in Fig. 10 are finished on a No. 2-A universal hollow hexagon turret lathe by means of the tooling equipment illustrated in Fig. 11. The successive steps of this operation are

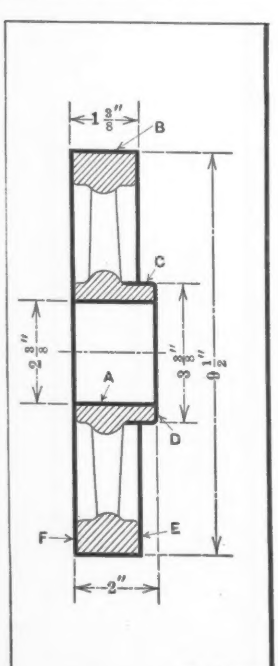


Fig. 10. Detail of Spur Gear

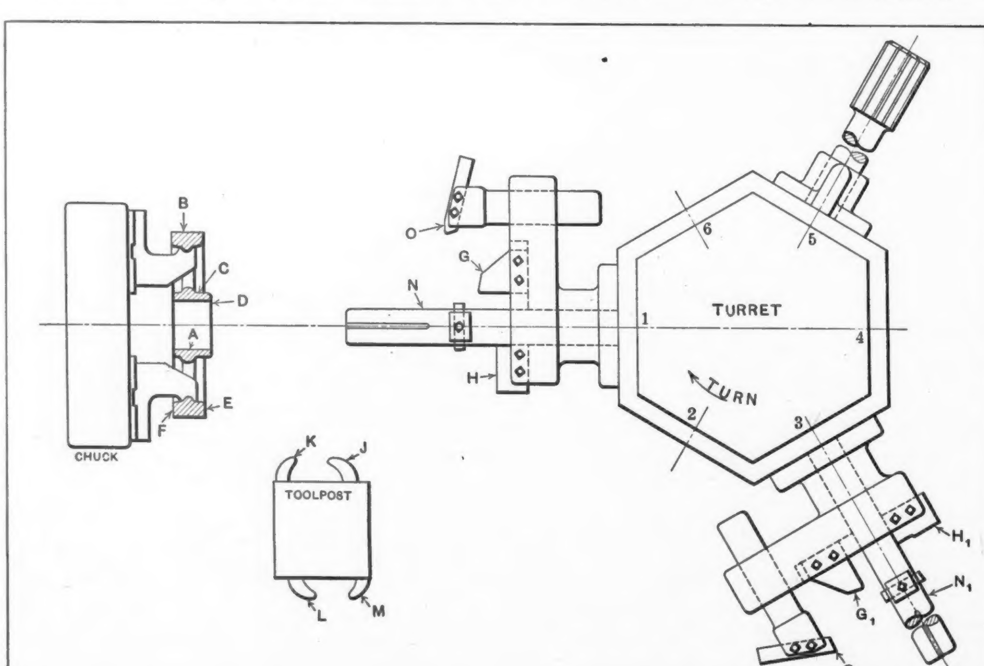


Fig. 11. Tool Lay-out for finishing Spur Gear shown in Fig. 10

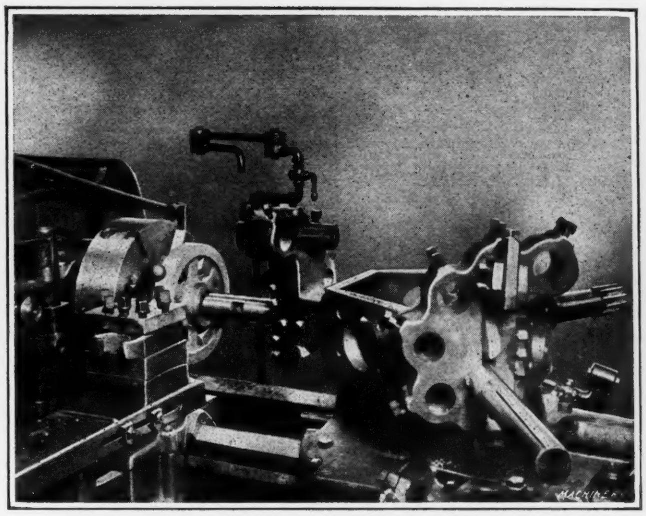


Fig. 12. Machine engaged in taking the Finishing Cuts on the Gear Faces

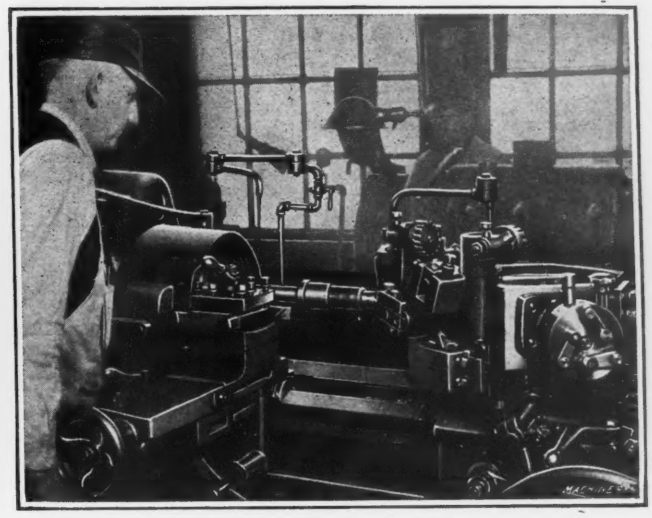


Fig. 13. Illustration showing Machine engaged in turning a Part from Bar Stock

taken in the following order: (1) The gear is held in a chuck equipped with special jaws which, when expanded, grip the gear on the inside of the rim. (2) Hole *A* is rough-bored by the cutter held in boring-bar *N;* rim *B* is rough-turned by cutter *O* held in an angle cutter-holder; surface *C* is rough-turned by cutter *G;* and hub *D* is faced by cutter *H*, all of these tools being mounted on the turning and facing head mounted in Face 1 of the turret. At the same time roughing cuts are taken on faces *E* and *F* by cutters *J* and *K*, which are held in the square turret. A machine engaged in taking the cuts of this step is shown in Fig. 12. (3) Hole *A* is finish-bored by the cutter held in boring-bar N_1; surface *B* is finish-turned by cutter O_1; surface *C* is finish-turned by cutter G_1; and hub *D* is finish-faced by cutter H_1, all of these tools being mounted on the turning and facing head in Face 3 of the turret. At the same time finish cuts are taken on faces *E* and *F* by cutters *L* and *M* which are mounted in the square turret. (4) Hole *A* is reamed by the reamer mounted in Face 5 of the turret. The total time required for finishing this gear is 6 minutes.

Machining Forged Steel Bushings

The forged steel bushing illustrated in Fig. 14 requires two chuckings to finish it all over, a No. 2-A universal hollow hexagon turret lathe being used for this purpose. Both chuckings are performed in 15 minutes. The tooling equipment used in the first chucking is shown in Fig. 15. The various steps of this operation are taken in the following procedure: (1) The work is placed and secured in the chuck. (2) Hole *A* is rough-bored by the cutter held in boring-bar *G*. The pilot of the boring-bar enters into bushing *H*, thus serving to properly locate the cutter for taking this cut. At the same time, surface *B* is rough-faced by cutter *I*, and surface *C* is rough-turned by cutter *J*. Boring-bar *G* and cutters *I* and *J* are held in the turning and facing head mounted in Face 1 of the turret. (3) Hole *A* is finish-bored by the cutter held in boring-bar G_1, the pilot of which also extends into bushing *H* while this step of the operation is being performed; surface *B* is finish-faced by cutter I_1; and surface *C* is finish-turned by cutter J_1. These tools are held in the turning and facing head held in Face 2 of the turret.

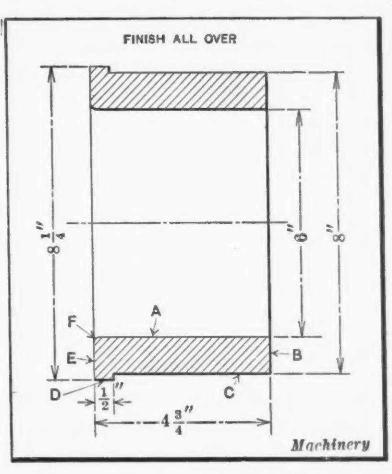


Fig. 14. Drawing of Forged Steel Bushing

A lay-out of the tooling equipment employed in the second chucking on the bushing is shown in Fig. 16. The successive steps in this operation are as follows: (1) The work is placed and secured in the chuck, which is provided with jaws that grip the work on the previously finished surface *C*. (2) Surface *D* is rough- and finish-turned by cutters *K* and *L*, and surface *E* is rough-faced by cutter *M*, these cut-

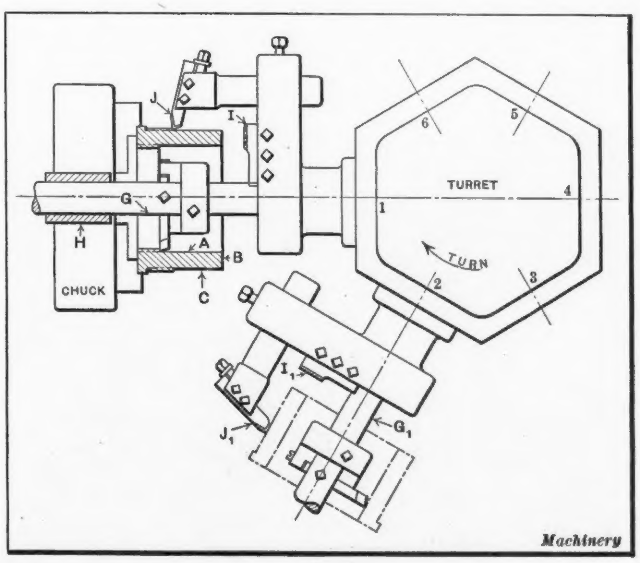


Fig. 15. Lay-out of Tools used in performing First Operation on Bushing

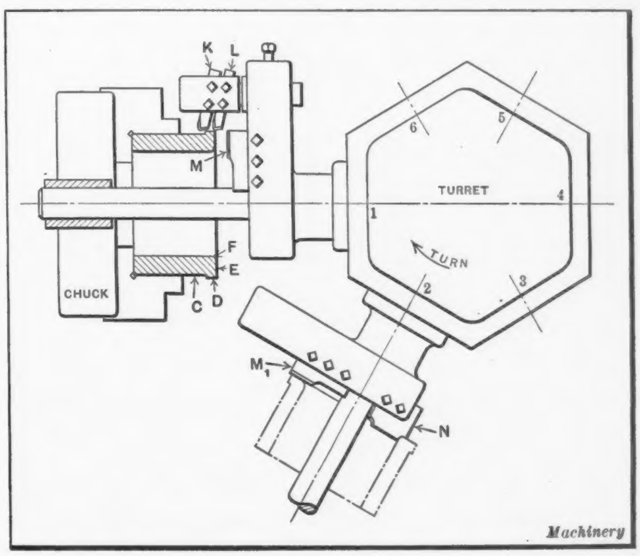


Fig. 16. Tooling Lay-out for Second Operation on Forged Steel Bushing

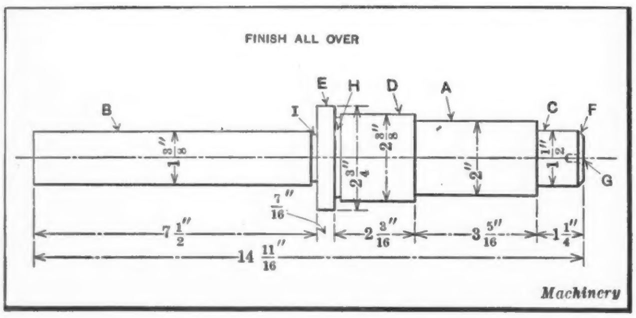


Fig. 17. Dimensioned Drawing of Stud machined from Bar Stock

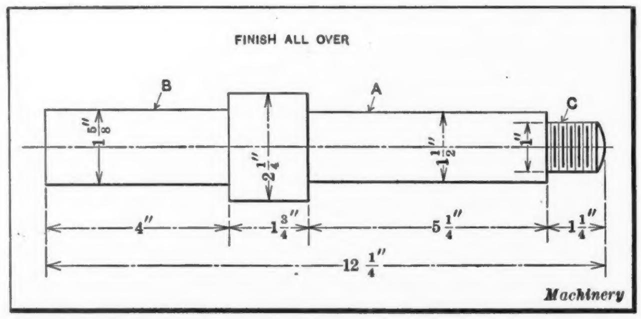


Fig. 18. Detail of Part turned from a $2\frac{1}{4}$-inch Steel Bar

ters being held in the turning and facing head mounted in Face 1 of the turret. (3) Surface *E* is finish-faced by cutter M_1 and the rounded corner *F* is turned by cutter *N*, these tools being held in the turning and facing head in Face 2 of the turret. The work is also indicated on this head by dot-and-dash lines.

Tooling Equipments Employed in Turning Various Pieces of Work from Bar Stock

The remaining examples of turret lathe practice to be presented in this article consist of parts turned from bar

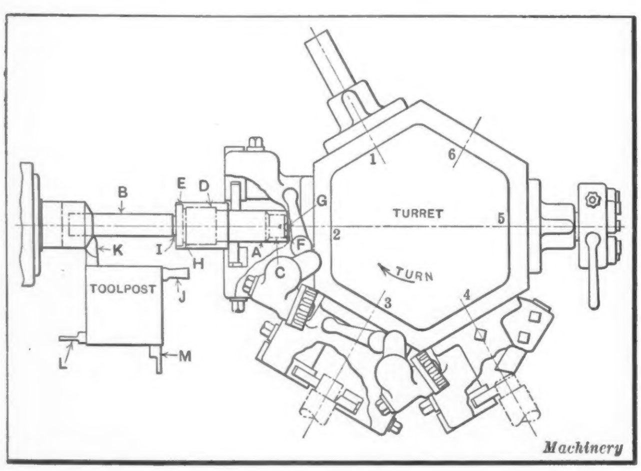


Fig. 19. Tooling Equipment used in producing Work illustrated in Fig. 17

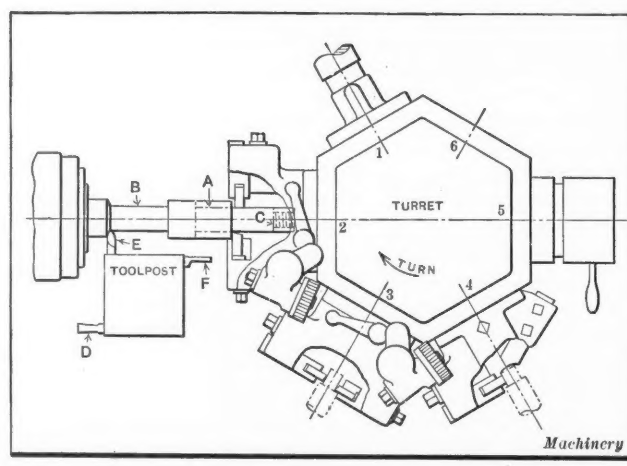


Fig. 20. Lay-out of Tools used to manufacture Work shown in Fig. 18

stock, and in each case a No. 2-A universal hollow hexagon turret lathe is used to perform the operation. In the lay-out of the tooling equipment for each operation, the work is shown partly completed, while the finished piece is indicated by dot-and-dash lines. A machine engaged in producing a stud from a steel bar $2\frac{7}{8}$ inches in diameter is shown in Fig. 13, which clearly illustrates the equipment used for manufacturing this piece. A detail of the work is shown in Fig. 17, while a lay-out of the tooling equipment used is shown in Fig. 19. The successive steps in the operation are as follows: (1) The stock is fed up to the stop mounted in Face 1 of the turret. (2) Surface *A* is turned by the cutter held in the universal turner which is mounted in Face 2 of the turret, and at the same time, the work is cut into at the left end of surface *E* with cutter *J*, which is held in the square turret, preparatory to turning surface *B*. The square turret is then indexed and surface *B* is turned by cutter *K*, one half of the surface being turned during this step, while the remainder is turned during the next or third step of the series. (3) Surface *C* is turned by the cutter held in the universal turner which is mounted in Face 3 of the turret, while surface *B* is completed by cutter *K*, as previously mentioned. (4) Chamfer *F* is cut by the pointing tool held in Face 4 of the turret. (5) Center *G* is drilled by the centering tool mounted in Face 5 of the turret. (6) Surfaces *D* and *E* are turned by cutter *K*, and grooves *H* and *I* are cut by cutter *L* which is held in the square turret. (7) The work is finally cut from the stock by cutter *M* which is also mounted in the square turret. The total time required for producing this part is 14 minutes.

In Fig. 18, is shown a piece of work made from a cold-rolled steel bar, $2\frac{1}{4}$ inches in diameter. Seven minutes is the time required for producing this part. The tooling equip-

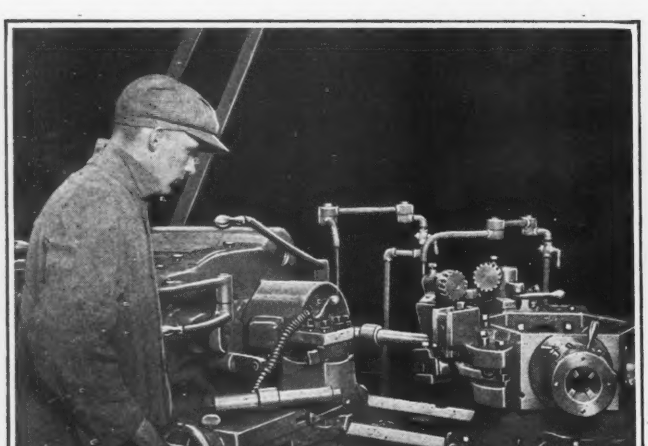


Fig. 21. Turret Lathe machining Work illustrated in Fig. 18

Fig. 22. Same Machine cutting Completed Piece from Stock

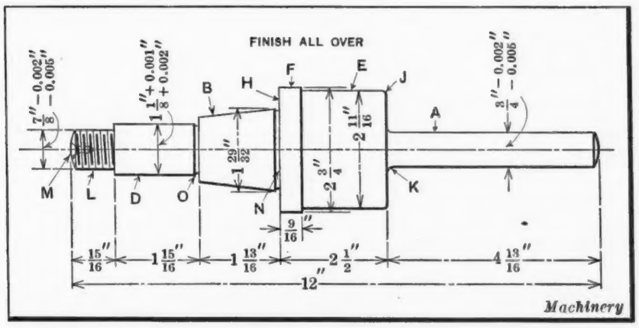


Fig. 23. Drawing of Work which is machined by Tooling Equipment shown in Fig. 25

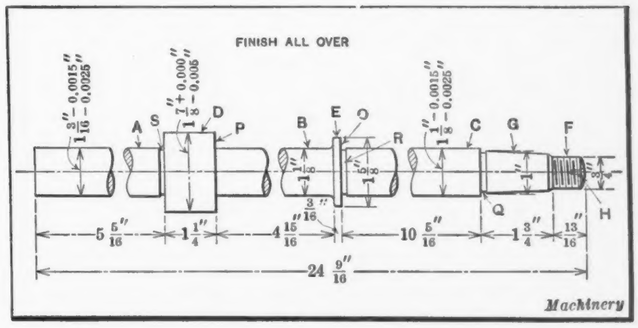


Fig. 24. Pinion-shaft which is manufactured by Means of the Equipment shown in Fig. 26

ment used in this operation is illustrated in Fig. 20. The various cuts are taken in the following order: (1) The stock is fed to the stop held in Face 1 of the turret. (2) Surface *A* is turned by the cutter held in the universal turner mounted in Face 2 of the turret; then cutter *D*, which is mounted in the square turret, is fed into the work preparatory to turning surface *B*, after which this surface is turned by cutter *E* which is also mounted in the square turret. (3) End *C* is turned by the cutter held in the universal turner in Face 3 of the turret. The machine shown in Fig. 21 is engaged in performing this step of the operation. (4) End *C* is rounded by the pointing tool in Face 4 of the turret. (5) End *C* is threaded by the die-head held in Face 5 of the turret. (6) The work is finally cut off by cutter *F*, which is mounted in the square turret. Fig. 22 shows a view of the machine at the end of the operation, when the completed work is being cut from the stock.

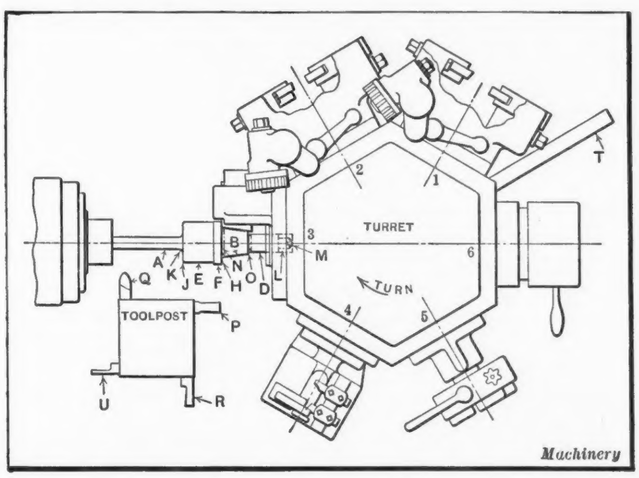


Fig. 25. Tooling Lay-out for machining Part shown in Fig. 23

The piece of work which is detailed in Fig. 23 is turned from a steel bar 2⅞ inches in diameter. Fig. 25 shows the lay-out of the tooling equipment used in producing this piece of work. The various steps in the operation are performed in the following manner: (1) The stock is fed up to stop *T* which is mounted in the corner of the turret adjacent to Faces 1 and 6. (2) The stock is cut into by cutter *P*, which is mounted in the square turret preparatory to turning surface *A*; the right end of the work up to face *H* is turned to the largest diameter of surface *B* by the cutter mounted in the universal turner held in Face 1 of the turret; and surface *A* is turned at the same time by cutter *Q* which is held in the square turret. (3) The right end of the work up to the right end of surface *B* is turned to the diameter of surface *D* by the cutter held in the universal turner mounted in Face 2 of the turret, while surfaces *E* and *F* are turned by cutter *Q*. (4) Surface *B* is taper-turned by the

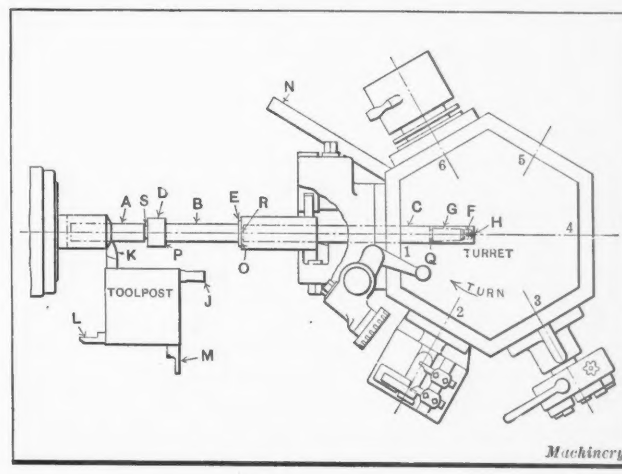


Fig. 26. Equipment for producing Pinion-shaft shown in Fig. 24

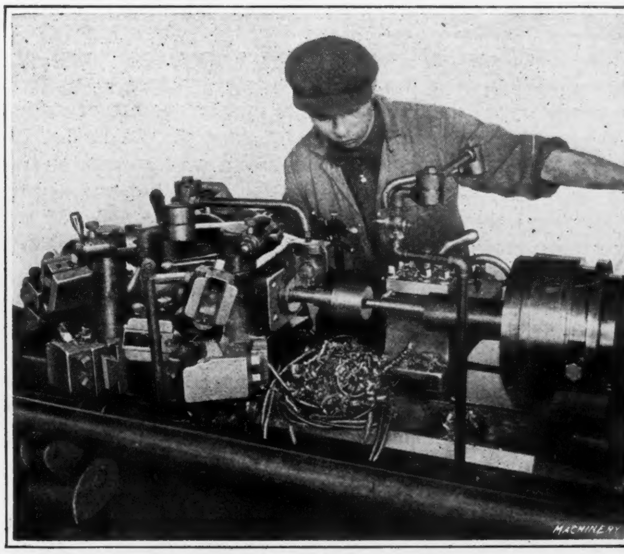


Fig. 27. Machine taking Finishing Cut on Slender Portion of Work shown in Fig. 23

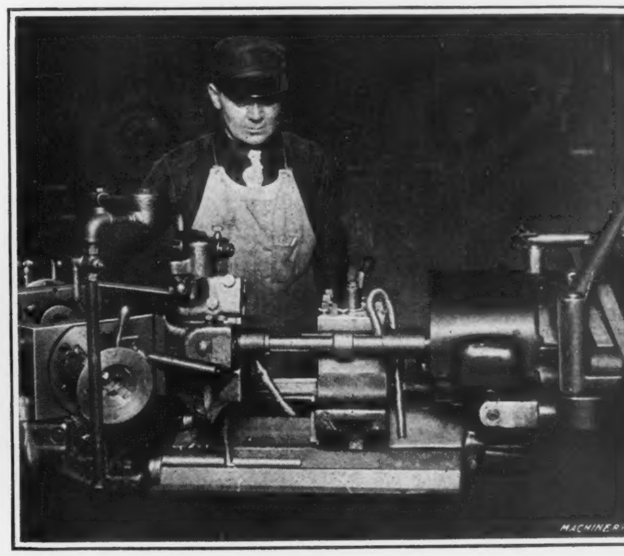


Fig. 28. Rear View of Lathe machining Pinion-shaft illustrated in Fig. 24

taper tool mounted in Face 3 of the turret, the work being supported while this cut is being taken, by extending into a bushing in this tool. (5) Surface *H* is faced; corner *J*, rounded; and fillet *K* and surface *A* finish-turned, all of these cuts being taken by cutter *Q*. Fig. 27 gives a close-up view of a machine engaged in taking the finishing cut on surface *A*, the end of the work still being supported in the bushing in the taper tool in Face 3 of the turret. (6) End *L* is turned by the multiple cutter turner mounted in Face 4 of the turret, which also rounds the tip of this end. (7) Center *M* is drilled by the centering tool held in Face 5 of the turret, while grooves *N* and *O* are cut at the same time by cutter *U* which is mounted in the square turret. (8) The threads are cut on end *L* by the die-head mounted in Face 6 of the turret. (9) Finally, the work is cut off by cutter *R* which is mounted in the square turret. The time required to produce this piece of work is 18 minutes.

Fig. 24 shows the detail of a pinion-shaft which is turned from a 2-inch diameter steel bar in 25 minutes, the machine employed for this operation being equipped with the tooling arrangement illustrated in Fig. 26. The various steps in the operation are performed in the following sequence: (1) The stock is fed to stop *N* which is mounted in the corner of the turret adjacent to Faces 1 and 6. (2) Surfaces *A* and *B* are cut into by cutter *J*, which is held in the square turret, preparatory to turning these surfaces; the right end of the work up to face *O* is turned to the diameter of surface *C* by the cutter held in the universal turner mounted in Face 1 of the turret; and surfaces *E*, *B*, *D*, and *A* are turned at the same time by cutter *K*, which is also held in the square turret. (3) End *F* is turned and its tip formed by the multiple cutter turner held in Face 2 of the turret. (4) Center *H* is drilled by the centering tool mounted in Face 3 of the turret. (5) Surfaces *O* and *P* are faced by cutter *J*. (6) A groove is cut into the work at the right end of surface *C* by cutter *J* preparatory to turning surface *G*. (7) Surface *G* is taper-turned by means of a taper attachment mounted on a base attached to the front of the carriage, beneath the cross-slide. (8) Grooves *Q*, *R*, and *S* are cut by cutter *M*, which is held in the square turret. (9) End *F* is threaded by the die-head mounted in Face 6 of the turret. (10) Finally, the work is cut from the bar stock by cutter *L* which is held in the square turret. Fig. 28 shows the rear view of a machine provided with the tooling equipment for producing this piece of work.

* * *

BONUS DISTRIBUTION BASED ON LENGTH OF SERVICE

The Fellows Gear Shaper Co., Springfield, Vt., announces that following a custom inaugurated in 1916 the company has distributed an annual cash bonus to its employes. Approximately 665 men received this bonus which amounted to a total of $25,000. The bonus is governed by the length of continuous employment and is based upon the total wages earned during the past year. For the first and second years it is 2 per cent of the total wages earned and increases by 1 per cent each succeeding year up to 10 per cent. The bonus distribution this year was of special interest to those who were in the government service during the war. To all those who returned to the employ of the company the bonus was calculated from the time of their original employment, so that when they returned, they were not considered new employes, and the time spent in the service of their country was not deducted.

The custom inaugurated by the Fellows Gear Shaper Co. is one that has proved to be very valuable in creating a feeling of cooperation between employers and employes, and it is believed that in carrying out this system to its fullest extent, granting the men that have remained in continuous service of the company for a period of years a higher bonus than those who have only been with the company a short time, an incentive is created for the men to remain with the company, and not to change their employment from time to time.

ELECTRICALLY HEATED PATTERN PLATES ON MOLDING MACHINES

By JOHN M. STRAIT
Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

The production of clean, smooth castings from molds made with metal patterns depends upon the molding sand not sticking to the patterns when they are removed from the sand. There is a tendency for moisture to collect on the cold metal pattern from the moist sand, or for the cold plate to "sweat." When this moisture collects, the sand sticks to the pattern being removed from the mold, and the mold acquires a rough surface, so that when the metal is poured, the casting will be rough. The pattern will have a rough surface due to the adhering sand, so that the next mold will also be rough unless the pattern is cleaned off and dried. This trouble is experienced in both summer and winter. The collection of moisture can be prevented by heating the pattern. The heat applied, however, must not be so great as to cause the sand in the mold to dry, as it would then crumble away and again the casting would have a rough surface. Furthermore, the heat must be applied in such a way that the pattern can be conveniently changed when desired. The usual method of heating is by means of a gas flame left burning in the space underneath the pattern within the framework of the molding machine. It is difficult to keep the flame low enough so that it will not heat the pattern too much, and a larger flame than necessary is therefore employed at some distance from the surface of application. This makes an inefficient arrangement, as most of the heat is dissipated into the surrounding space. The surrounding air becomes contaminated by the gas fumes, and in summer, there is further discomfort due to the heating of the surrounding air. Difficulty is also experienced from variation of gas pressure, so that at one time the pattern is too hot and at another too cold. When the pattern gets too hot, it is necessary to cut off the gas, and when it has cooled down, the gas must be relit and readjusted.

A much more convenient method of heating is by the use of electric heaters. Two steel-clad heaters are mounted in the space immediately below the metal pattern plate, within the framework of the molding machine. In order to use as little heat as possible, they are located just below the thickest pattern used. They are attached to supporting angles fastened to the frame of the machine. It is obvious that any pattern of any thickness and of any size within the capacity of the machine may be attached to or removed from the molding machine without disturbing the heaters. An asbestos insulating plate is placed just below the heaters, to prevent loss of heat due to radiation downward from the heaters. The entire installation is made in such a way as not to interfere with the usual operation of the machine, and without any modification of the machine other than to drill and tap small holes for attaching the mounting angles.

The advantages of electric heaters over gas flames are obvious. When it is desired to heat the pattern plate, it is not necessary to hunt for a match, and to operate or adjust valves until the correct degree of heat is obtained. Instead, it is only necessary to plug into a wall receptacle and give no further thought to the matter, since but one degree of heat, and that the correct one can be obtained. If for any reason, such as the machine standing idle, the pattern plate should be overheated, it is not necessary to operate any valves, such as shutting off the gas, until the temperature becomes right and then relight and readjust the valves. Instead, it is only necessary to pull the plug from the wall receptacle and leave the heater disconnected until the temperature becomes right, and then plug it in again. Furthermore, there is no trouble from variation of gas pressure.

* * *

Workmen's compensation laws are now in force in forty-two of the states and territories, the only six states not having such laws being Arkansas, Florida, Georgia, Mississippi, North Carolina, and South Carolina.

Practice in Making Component Drawings

By EARLE BUCKINGHAM
Engineer, Pratt & Whitney Co., Hartford, Conn.

Second of Two Articles on the Application of the Principles of Dimensioning Drawings and Indicating Tolerances

IN this article, which is the concluding one on component drawings, additional details of the firing mechanism illustrated in the January number are referred to, this mechanism having been selected as a practical example for illustrating the general principles which govern methods of dimensioning drawings.

Drawing of Primer Extractor

The outside diameter of the primer extractor (see Fig. 8) which is 1.102 inches, plus 0.000, minus 0.006, should approximately match the corresponding diameter on the container shown in Fig. 7 in the January number. The surface should be reasonably smooth. The diameter of the recess for the firing pin guide (0.791 inch, plus 0.01, minus 0.00) is clearance and is unimportant. The depth (0.264 inch, plus 0.005, minus 0.000) is more important, as it controls the amount of surface which engages the head of the primer. A finish cut will be required on this surface.

The width of the extractor slot (0.472 inch, plus 0.004, minus 0.000) is an important dimension and the surface must be smooth. A finish cut will be required. The bevel at the end of this slot is at an angle of 30 degrees and is located from the center of the extractor at a distance of 0.236 inch, plus 0.01, minus 0.01. The exact dimensions of the bevel are unimportant, as it is provided merely to facilitate assembling the primer. The surfaces must be smooth, however, even if an extra filing operation is needed to match the cuts.

The distance across the flats (0.945 inch, plus 0.00, minus 0.01) is for the wrench used in assembling and is unimportant. No finish cuts are required. The length of the extractor is 0.394 inch, plus 0.00, minus 0.01. The front face must clear the rear face of the spindle plug when the primer is seated; therefore, no plus variation is permissible. Any great minus variation will weaken the extractor. The tolerance given should be liberal enough for all normal manufacturing purposes. Both the front and rear surfaces should be reasonably smooth. This will require finishing cuts.

The depth of the tapped hole is 0.209 inch, plus 0.00, minus 0.01, and the width of the thread under-cut, 0.06 inch, plus 0.005, minus 0.000. Enough threads must be secured to hold the extractor firmly in position, yet the depth must be shallow enough to permit the extractor to seat on the front face of the container. It is permissible to make the depth of the thread under-cut not over 0.005 inch below the bottom of the threads to provide clearance for the tap. A greater diameter of under-cut than 1.042 inch (maximum outside diameter of thread or 1.032 inch plus 0.01 in diameter allowed for tap clearance) would weaken the extractor to such an extent that it would not be safe to use it in service.

The location of the bottom of the primer slot from the rear face is 0.248 inch, plus 0.000, minus 0.005. This surface should never come below the corner on the firing pin guide, for if it did, it would be difficult to insert the primer. The surface should be smooth and all corners about this slot must be carefully broken.

Method of Dimensioning to Prevent Compound Tolerances

The countersink which merges into the beveled surface on the under side of the primer head is located from a theoretical point, where its angle of 35 degrees intersects the center line of the extractor. The distance from this intersecting point to the front face is 0.306 inch, plus 0.005, minus 0.000. Such a method of dimensioning is necessary to prevent compound tolerances. It will be noted that no dimensions are given for the intersections of this angle with the primer slot or bottom of the recess. Such dimensions are unnecessary and could not be measured directly in any event. The dimensions given locate this surface definitely and completely. It will be necessary for the manufacturer to compute the diameters on this countersink to suit his own particular needs. This surface must be smooth and will require a careful finishing operation.

No tolerances are given on any of the angles or radii because none are needed. Sufficient variation on these surfaces is permitted by the tolerances given on other dimensions.

Drawing of Locking Latch, Spring, and Pin

The surfaces of the locking latch (Fig. 9) must be smooth, as they bear on the sides of the slot in the container. This part has a tolerance of minus 0.01 inch on the entire contour. This means that the piece may vary 0.01 inch normal to the profile at any point in the direction that will make the piece smaller, or, in other words, any variation from the normal dimensions must remove more metal. The diameter of the pin hole (0.092 inch, plus 0.004, minus 0.000) corresponds with the pin hole in the container. The diameter of the spring hole (0.175 inch, plus 0.01, minus 0.00) also corresponds with the spring hole in the container.

The locking latch spring (Fig. 9) is a part of minor importance. It is made of No. 10 music wire, and no tolerance is specified for its diameter. This means that commercial music wire bought in the open market will be satisfactory. No difficulty should be experienced in maintaining the limits given.

The thread of the locking latch pin is a No. 5-44 U. S. form. This is a standard A. S. M. E. thread, and dies should be available in stock at any reliable die manufacturer's. After this pin is assembled into the container, the end thread of the tapped hole in the container should be upset slightly with a punch to prevent this pin from falling out. It should be understood that it is permissible to bevel at both ends of the thread to facilitate the threading. The surface of the

stem forms a bearing for the latch and should receive a finish cut. This part should be completed in a single operation on a screw machine.

Drawing of the Housing

The outside diameter of the housing (Fig. 10) is 2.638 inches, plus 0.00, minus 0.01. This is an atmospheric fit and requires no finishing cut, which also applies to the shoulder, the diameter of which is 1.925 inches, plus 0.00, minus 0.01. The Whitworth thread, the full diameter of which is 2.100 inches, plus 0.012, minus 0.000, must assemble on the hinged collar (Fig. 11). The Whitworth form of thread is used to suit other types of firing mechanisms now in service; otherwise the U. S. form of thread would be preferable.

The counterbore in the front end (diameter 1.502 inches, plus 0.02, minus 0.00) must clear the spindle plug. No finishing cut is required. The counterbore in the rear end of the same size must clear the flange on the container. The minimum clearance is 0.007 inch and the maximum clearance, 0.047 inch. No finish cut is required. The full diameter of the container thread is 1.425 inches, plus 0.006, minus 0.000. A sector of this thread is removed to permit the assembly of the container. All of these surfaces require finishing cuts. The rear flank is the bearing flank and the most essential. The requirements were previously given in connection with the firing mechanism container. The front face of the housing should be reasonably smooth, as it seats against the hinged collar and is the most important working point for other machining operations.

The depth of the Whitworth thread is 0.80 inch, plus 0.02, minus 0.00. The hole must be deep enough for the hinged collar and enough threads must be maintained to hold the firing mechanism in position during the firing of the gun. This thread is subjected to a considerable strain at this time. The depth of the counterbore in the front end is 1.08 inches, plus 0.02, minus 0.00. This surface must clear the end of the spindle plug. No finish cut is required.

The location of the thread for the container is 1.987 inches, plus 0.005, minus 0.000 from the front end. This is an important functional dimension and must be carefully watched, as it controls the angular position of the firing mechanism when it is screwed home. A minus variation on this dimension would prevent the mechanism from locking. A slot is shown in the lower right-hand side of the housing for the safety mechanism. The safety bar should be a very free fit in this slot. The slot is 1.59 inches, plus 0.01, minus 0.01 from the front end; the length, 0.75 inch, plus 0.02, minus 0.00; and the width, 0.375 inch, plus 0.02, minus 0.00. The surface in the slot should be reasonably smooth. A tapped hole, having a full diameter of 0.50 inch, plus 0.01, minus 0.00, is shown in the bottom of the housing for the firing mechanism pin. It is permissible to run the tap drill below the thread, provided that this drill does not break through into the hole in the center of the housing.

A recess is milled in the rear face of the housing to engage the locking latch. This recess allows for a possible

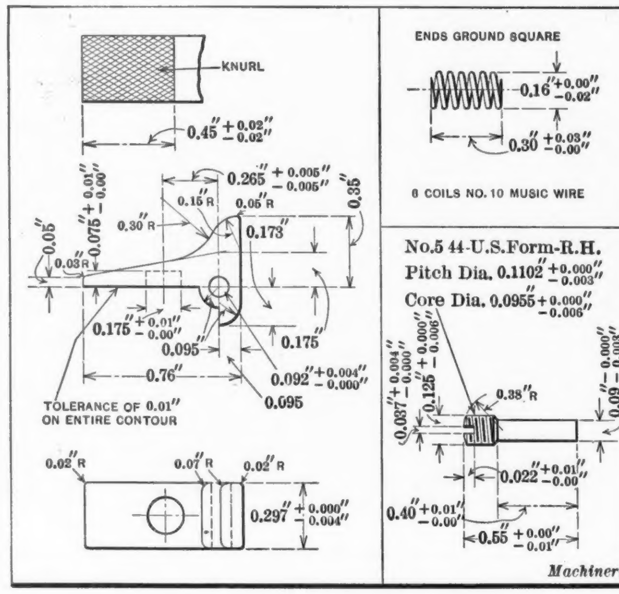


Fig. 9. Locking Latch, Spring, and Pin

variation in the locked position of the container of 90 degrees. The tolerances given on the various controlling dimensions will permit a variation of approximately 30 degrees. The variations on the primer plug and the primer will permit approximately 30 degrees more. This leaves the remaining 30 degrees to allow for wear. The depth of the recess is 0.10 inch, plus 0.02, minus 0.00 and the ends of the recess are located 0.15 inch, plus 0.01, minus 0.00 from the center lines through the rear face, 90 degrees apart.

The hole and counterbores for the collar-catch (shown in Fig. 12) are located from the center of the housing because these holes will be drilled in a jig which should locate the housing centrally. The counterbores are 1.088 inches, plus 0.000, minus 0.005, and the hole, 1.183 inches, plus 0.005, minus 0.000 from the center line (see end view Fig. 10). The diameter of the hole is 0.16 inch, plus 0.006, minus 0.000. This hole should be a free sliding fit for the stem of the collar-catch. The minimum clearance is 0.002, and the maximum clearance, 0.014 inch. The full diameter of the tapped hole is 0.375 inch, plus 0.008, minus 0.000, and the pitch diameter, 0.3417 inch, plus 0.004, minus 0.000. No core diameter is given as the small counterbore, which is a few thousandths inch larger than the theoretical core diameter, limits the height of the threads. The V-form of thread is used to obtain as great an area of contact as possible. After assembly of the collar-catch screw, the metal should be upset slightly with a cold chisel into the slot of the screw to prevent disassembling. The bottom of the counterbore is 0.125 inch, plus 0.02, minus 0.00 from the rear face of the body. This counterbore receives the head of the collar-catch screw and also forms a groove in the stem which provides clearance for drilling and tapping.

The width of the thread for the container is 0.41 inch, plus 0.01, minus 0.00. A 45-degree bevel (0.03 inch, plus 0.02, minus 0.00 wide) is required on the corner of this thread to facilitate the insertion of the container. This bevel may be made with a file; the tolerance should be great enough to cover this method of manufacture. The ends of the thread sector are located from the 45-degree center line of the housing (see end view) at 0.02 inch, plus 0.02, minus 0.00. This sector is at an angle so as to always insure a minimum contact on this thread of 135 degrees. No tolerances are given on the various angles and radii, as none are required.

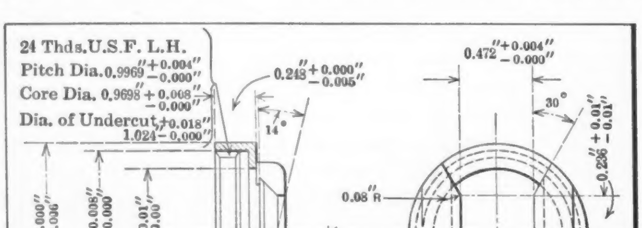


Fig. 8. Primer Extractor

Drawing of Hinged Collar

The hinged collars and housings are not interchangeable and must be furnished in pairs. To make these parts interchangeable and insure that the housing would be screwed tightly against the shoulder on the hinged collar when the locking holes in each part were in correct alignment, would require very expensive manufacturing methods. In such a

case, the position of the start of the Whitworth thread in the housing would have to be held very closely in relation to the position of the locking hole. The same would be true on the hinged collar. Some variation must of necessity be allowed. This would introduce a further variation longitudinally of the position of the firing mechanism. The effect of such a variation would be an additional angular variation in the locked position of the mechanism. If the original pairs of housings and hinged collars become separated, an additional locking hole will have to be drilled in the flange of the collar, Fig. 11, transferring it from the housing which is to be used. The diameter of the locking hole is 0.160 inch, plus 0.006, minus 0.000. This hole should be drilled in a single operation by using its companion housing as a jig.

Drawing of Collar-catch

For convenience of manufacture, the collar-catch (see Fig. 12) is made in two parts which are permanently assembled. The stem and the finger piece may be made interchangeable, or a system of selective assembly may be employed. This is a matter to be determined by the manufacturer to suit his own convenience. Therefore no tolerances will be given on the dimensions of the riveted end. The stem must be a snug fit in the finger piece, and the two parts must be solid after riveting. Any parts made within 0.01 inch of the nominal dimensions and which meet the above conditions will be acceptable. The rear face of the finger piece will be finished after riveting.

As the diameter of the stem is 0.158 inch, plus 0.000, minus 0.006, it should be possible to secure drill rod well within these limits; no further machining will be required on this surface. The length of the stem is of minor importance. The surface left by the cutting-off tool will be satisfactory. The length of the finger piece (0.525 inch) is an atmospheric fit; no tolerances are given, because the note in regard to the profile gives a tolerance of minus 0.04 inch.

The thickness of the flange (0.125 inch plus 0.00, minus 0.01) is of minor importance; hence the flange can be completed in a single operation after the stem is riveted. The width of the flange (0.245 inch, plus 0.00, minus 0.01) must be free in the slot in the housing. The minimum clearance is 0.005 inch and the maximum clearance, 0.035 inch.

The dimensions of the profile of the finger piece are given without tolerances, but a note is added: "Tolerance plus 0.00, minus 0.02, as shown by dotted line." The entire upper part of the finger piece is an atmospheric fit. It must be reasonably smooth because the finger operates this part. The note permits a minus variation of 0.02 on this profile where no other tolerances are given. This variation is measured as normal to the profile at any point. If a clean drop-forging is secured, this surface may be finished by removing all rough scale, flash, and other rough spots with a file or on a polishing wheel. The contour of this surface is not important enough to require expensive form milling cuts.

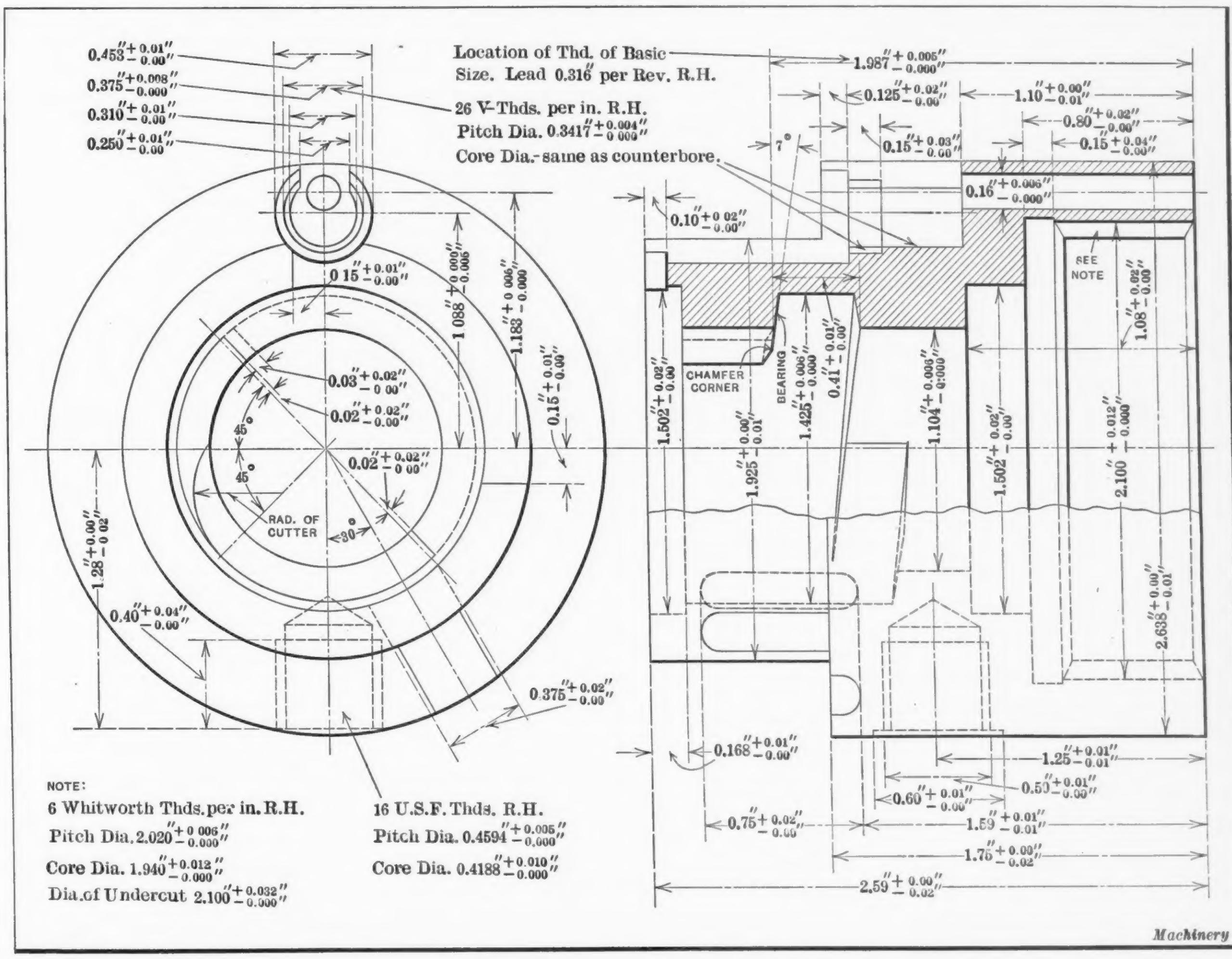


Fig. 10. Housing of Firing Mechanism

Drawing of Firing-pin Guide Spring and Firing Pin

The diameter of the wire for the firing-pin guide spring (Fig. 13) is 0.04 inch, plus 0.00, minus 0.002; the outside diameter of the coils, 0.464 inch, plus 0.00, minus 0.01; and the free height, 0.69 inch, plus 0.02, minus 0.00. These limits should be readily maintained under normal manufacturing conditions.

The firing-pin flange is 0.582 inch in diameter, plus 0.000, minus 0.003. This surface must be a free sliding fit in the firing-pin guide. The surface will require a careful finishing cut. The diameter of the front end (0.117 inch plus, 0.000, minus 0.003) must be a free sliding fit in the firing pin guide. This surface requires a careful finishing cut.

The surface of the rear end clears the hole in the container by 0.050 inch and requires no finishing cut. The diameter of the large end of the taper is an unimportant clearance surface. The taper is provided to strengthen the end of the firing pin. No finishing cut is required on this

tapered surface. The length over all is an important functional dimension and, in part, controls the force of the blow on the primer. The front face of the pin must be as smooth as possible, and a polished surface is desirable. The rear face should be as smooth as a careful finishing cut will leave it.

The location of the rear face of the flange (0.525 inch, plus 0.000, minus 0.003) is important, as this dimension controls the location of the end of the firing pin. The surface should receive a finishing cut. The distance to the front face of the flange is an important functional dimension which controls the protrusion of the firing pin, as noted in connection with the firing-pin guide. A finishing cut is

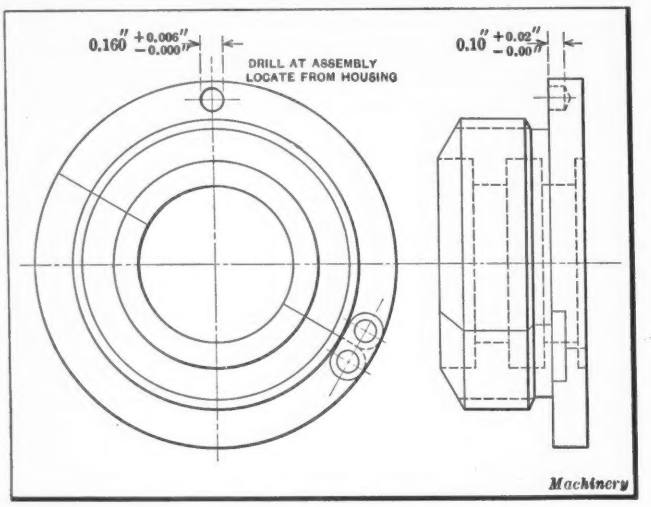


Fig. 11. Hinged Collar assembled

required on this surface. The location of the beginning of the taper is relatively unimportant. This dimension maintains clearance with the bottom of the counterbore in the firing-pin guide.

No tolerances are given for the radii because none are needed. Attention is called, however, to the radius of 0.04 inch at the front end. This must not be exceeded. The purpose of this radius is to remove the sharp corner, but care must be taken to remove as little material as possible.

Drawing of Collar-catch Screw and Spring

The collar-catch screw is shown in Fig. 14. The diameter of the head must enter the counterbore in the housing. The thread, which is a sharp V-form, must assemble into the tapped hole in the housing. Sufficient threads must be secured to hold the screw in position. It is permissible to bevel both under-cut and end to facilitate threading. This screw should be completed in a single operation on a screw machine.

No. 15 music wire is specified for the collar-catch spring. Commercial wire of this number will be satisfactory. The function of this spring is to hold the collar catch in its locked position. The limits given should be maintained readily under normal manufacturing conditions.

All dimensions and tolerances given on these drawings represent limit gage sizes. If a hole is given as 1.25 inches,

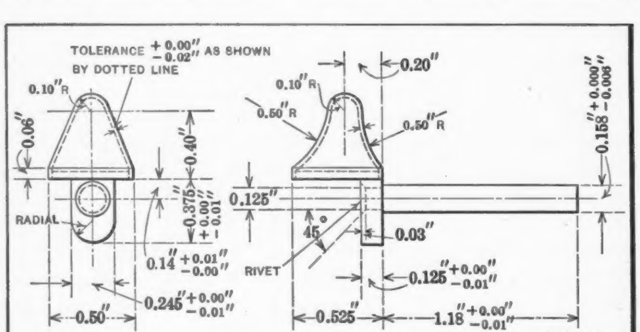


Fig. 12. Collar-catch

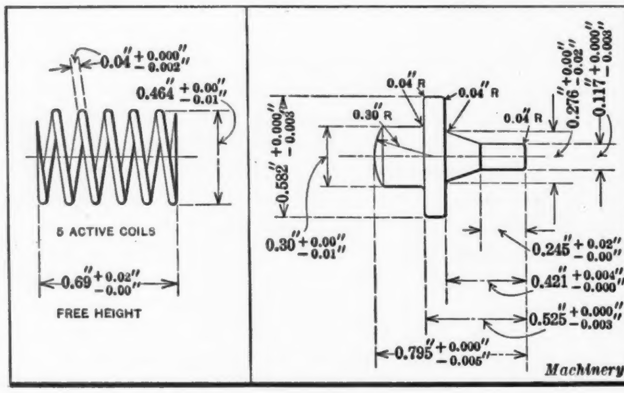


Fig. 13. Firing Pin Guide Spring and Firing Pin

plus 0.01, minus 0.00, this means that the hole must be made so that a plug gage, 1.25 inches in diameter will always enter, while a plug gage, 1.26 inches in diameter will not. In general, the extent of the tolerances allowed on any surface is a good index of the character of the finish required. All burrs, fins, etc., and unnecessary sharp corners must be removed. All cuts and surfaces, whether rough or finished, must show no evidence of carelessness. All cuts must be made with clean and sharp tools. Gouges, tears, and unnecessary scratches produced by dull or improper tools and careless workmanship or careless handling should be sufficient cause for rejection.

Unless noted otherwise, common manufacturing practices, such as under-cutting and beveling for threads, extending the tap drill a reasonable amount below the threads in tapped holes, countersinking to guide the tap, providing reasonable grinding clearances where necessary, burr-beveling corners

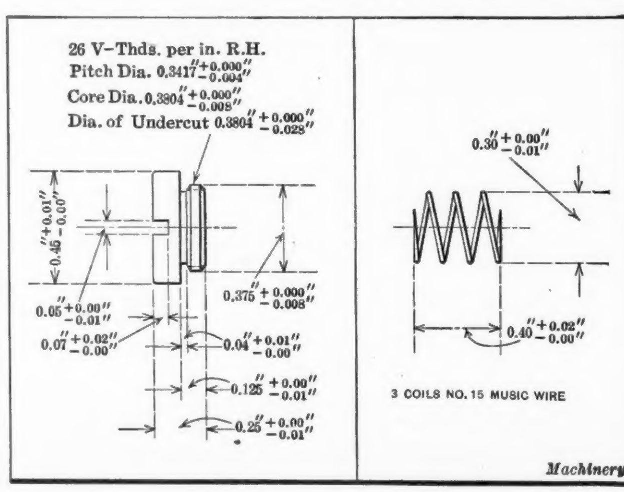


Fig. 14. Collar-catch Screw and Spring

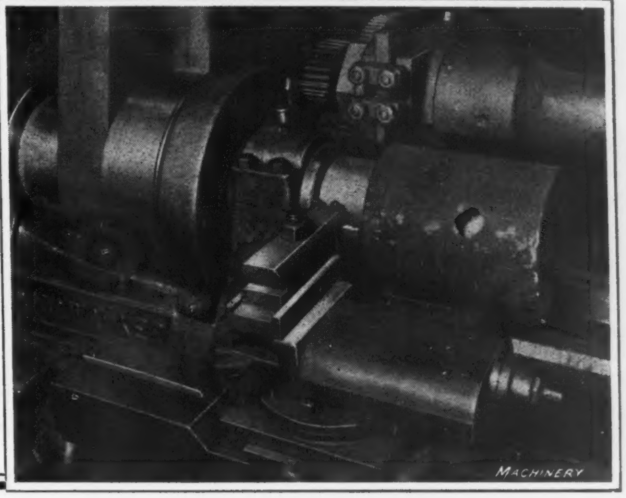
on screw machine parts, etc., are permissible. Whenever any differences exist between the dimensions and tolerances expressed on the drawing and the above specifications, the figures on the drawing should be used. The dimensions and tolerances given on the component drawings should be strictly maintained. If modifications are possible which will relieve the situation, they should be made. No deviations from the specified requirements are permissible, however, until definite modifications are authorized.

* * *

Trade commissioner Wilbur J. Page reports that German exports are severely hampered by the lack of certain raw materials and the shortage of coal. There was, however, a remarkable evidence of the revival of the German industries at the German national fair at Leipsig. Most of the 10,500 firms exhibiting were German, and 7000 foreign buyers are said to have been present. It was evident that the German manufacturers are concentrating on such products as require mechanical precision and where the cost of the raw material is a small percentage of the cost of the finished article.

Boring and Facing Pistons in a Lathe

A Description of Special Equipment for Performing Preliminary Operations on Pistons in an Engine Lathe



AT the motor works of the Avery Co., in Milwaukee, Wis., several Potter & Johnston piston turning automatics have recently been installed. In turning pistons on machines of this type, it is necessary to first perform a preliminary operation which consists of facing and boring the piston skirt. Owing to difficulty in obtaining prompt delivery on the particular type of machine required for the performance of this preliminary operation, James H. Pinson, general manager of the plant, designed and had built under his personal supervision special fixtures for use on standard 16-inch engine lathes; and after this equipment was placed in operation, it proved so efficient that its use is now regarded as a permanent feature of the piston department.

The heading illustration shows a close view of the boring and facing tools, and of the piston which is to be machined; and in Figs. 1 and 2, the mechanism of the facing attachment is fully illustrated. A feature of this method of machining is that the boring and facing operations are performed simultaneously, thus enabling a higher rate of production to be attained than would be possible if the two operations had to be performed independently. Also, the possibility of both boring and facing the work at a single setting is not only a means of saving time, but it also assures having the bore at an accurate right angle to the finished face. A special expanding chuck, illustrated in Fig. 3, is used to hold the work.

Reference to the heading illustration will make it apparent that the boring tool *A* is carried in a special form of offset tool-block supported on the compound rest, which is swung to an angle of 90 degrees with the direction of travel of the lathe carriage. By using the regular feed mechanism on the lathe, it is possible to feed tool *A* into the work to provide for boring out the flange that runs around the inside of the open end of the piston. In order to provide for performing this operation, the expanding chuck is so designed that the necessary clearance is provided for the boring tool and the slight amount of overhang of the block by which this tool is carried. Attention is called to the form of the tool-block, which has been so designed that provision is made for holding tool *A* by means of two setscrews, with very little of the block projecting beyond the tool.

The attachment that provides for facing the open end of the pistons is the most interesting part of this special equipment which is used by the Avery Co. for performing the preliminary machining operations on pistons. In Figs. 1 and 2, it will be seen that this consists of a pivoted lever *B*, at one end of which there is mounted a facing tool *C*, with a cam roller *D* mounted at the opposite end of the lever. Roller *D* runs in contact with a cam *E*, and as the roller rises over the lobe on this cam, it causes lever *B* to swing around its pivotal support, with the result that facing tool *C* is fed across the open end of the piston. Power for rotating the cam is derived from the lathe spindle, but it will be quite obvious that the speed of rotation must be substantially reduced in order to obtain a suitable rate of feed for the facing tool. This result is accomplished by a triple train of spur gears which effect a reduction of 168 to 1 in the speed. These gears are clearly shown in Fig. 1, where it will be seen that the final gear is mounted on the end of the cam hub. This cam rotates on its shaft.

In Fig. 1 it will also be noticed that a lever *F* is bolted to the top of arm *B*, with the outer end of this lever pivoted in a yoke at the upper end of rod *G*. Secured to the bed of the lathe, there is an inverted cup *H* that contains the compression spring *I*, which is depended upon to always keep roller *D* in contact with cam *E* so that a uniform feed movement of the facing tool is assured, and also the return of this tool to the starting position after the facing operation has been completed. It will, of course, be apparent that bracket *J*, which is machined to fit vees on the lathe bed, is bolted in place and furnishes the pivotal support for arm *B*.

An air cylinder is placed at the left-hand end of the lathe headstock to provide for manipulating the expanding chuck on which the work is carried. It will be seen from Fig. 3 that this chuck is arranged with plugs *K* at each end to grip the inside of the work and bring it into accurate alignment. Inside the bore of the chuck body there are two conical shaped members M_1 and M_2 that slide in opposite directions to engage the inner ends of plugs *K* and push them into firm contact with the inside of the work. These conical shaped members are caused

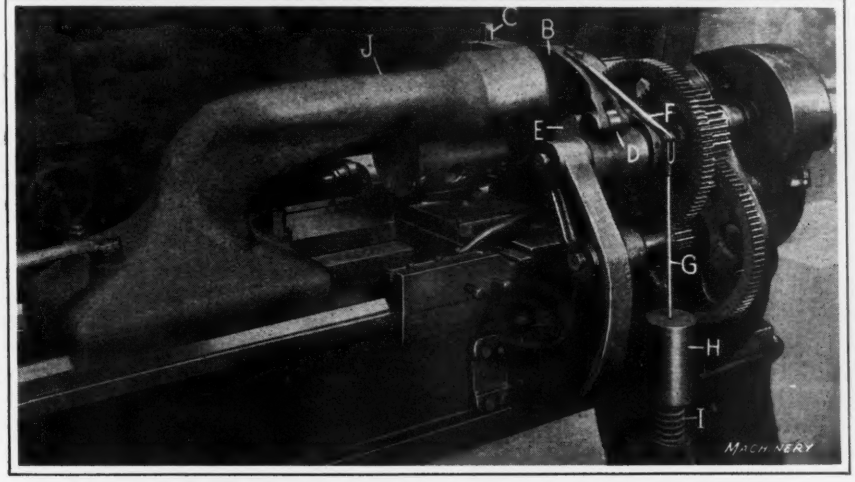


Fig. 1. Arrangement of the Cam-actuated Mechanism of the Piston Facing Attachment

to slide in opposite directions by admitting air to cylinder *N*. Rod *O* is fastened to the piston in this air cylinder and sleeve *P* is fastened to the cylinder wall. At its right-hand end, rod *O* has threaded in it the chuck expanding member M_1'; and similarly, sleeve *P* is threaded into the conical member M_2. Movement of rod *O* to the right caused by admitting air to cylinder *N*, allows the conical members M_1 and M_2 to expand plugs *K* inside the work and secure it firmly for the performance of the boring and facing operations. When the operation has been completed, it is merely necessary to reverse the air valves so that air will be admitted to the opposite side of the piston in cylinder *N*.

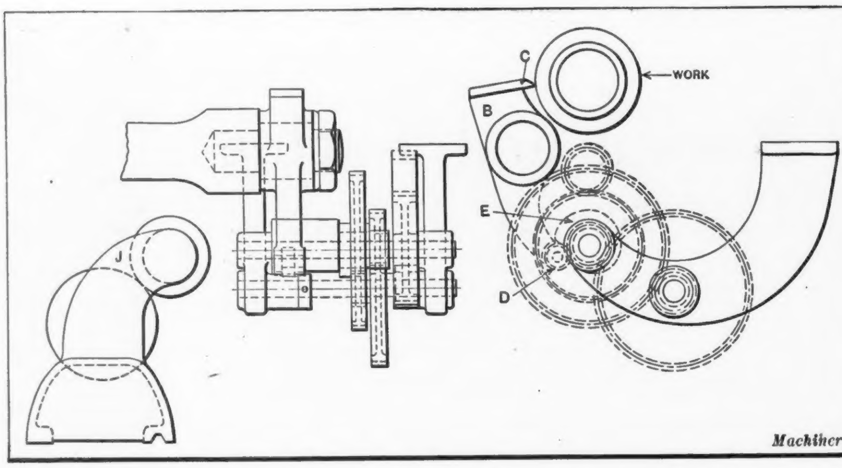


Fig. 2. Views of the Piston Facing Attachment from the Front and Ends, showing Details of the Mechanism

To fully understand the way in which movement of the piston in cylinder *N* is responsible for accomplishing the movement of the two chuck expanding cones M_1 and M_2 in opposite directions, it must be explained that rod *O* first moves to the right and carries M_1 with it. During this movement, collar *Q* compresses spring *R*. When cone M_1 has reached the limit of its travel, air pressure in cylinder *N* causes sleeve *P* by which the cylinder is carried to move to the left, thus carrying the chuck expanding member M_2 to the left. From this description it will be evident that the movement of cones M_1 and M_2 in opposite directions does not occur simultaneously. After the machining operation has been completed, the valve which governs admission of air to cylinder *N* is reversed, so that pressure is applied at the right-hand side of the piston in this cylinder instead of at the left. This results in withdrawing the conical member M_1 through movement of the piston and rod *O* toward the left; and at the same time the tension in spring *R* results in moving conical member M_2, sleeve *P*, and cylinder *N* carried by this sleeve, toward the right, thus returning the entire apparatus to the starting position. The bored and faced piston casting can now be removed from the chuck ready to have a fresh piece set up for the performance of the next machining operation.

* * *

SIZES OF CATALOGUES

The National Association of Purchasing Agents, having headquarters at 25 Beaver St., New York City, recommends that catalogues intended for purchasing agents be confined to one of the following three sizes: 6 by 9 inches, 7½ by 10⅝ inches, and 8 by 11 inches. It is further recommended that of these three sizes, the medium, or 7½ by 10⅝ inches, should be considered standard, the half size of this—that is, 5¼ by 7½ inches—being also considered standard. It is somewhat questionable, however, if so large a size as that recommended by the Association of Purchasing Agents is really desirable. It would seem that catalogues could well be confined to a size of 6 by 9 inches. It would make them handier to use, more compact, and they would occupy less space when filed. The general tendency of late years, of course, has been to increase the size of catalogues in order to afford more display, but when properly handled, it is possible to produce very good effects with both illustrations and text in the 6- by 9-inch size.

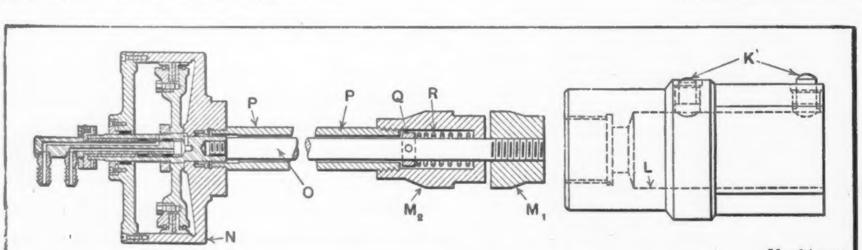


Fig. 3. Special Type of Air-operated Expanding Chuck used to hold the Pistons while the Boring and Facing Operations are performed

CURIOUS EFFECT OF LOW GERMAN EXCHANGE RATES

German industrial interests have of late been employing an unusual method for overcoming the difficulties due to the low value of the mark in foreign exchange, reverting, one might say, to the old methods of barter, or the direct exchange of goods. As an example, it is stated by the *Board of Trade Journal* that German industries have obtained from Holland untanned hides, taken them to German tanners and converted them into leather, returning them again into Holland with a certain number of hides deducted as payment for the tanning. In certain cases, however, the leather would be kept in Germany and turned over to a shoe manufacturer, where it would be converted into shoes; afterward the manufactured product would be sent to Holland, a certain quantity of the shoes made being retained by the manufacturer as payment for the making of the shoes. Aside from the amount of leather and manufactured goods thus retained in Germany, there is the advantage of being able to keep the German industries at work, which would be practically impossible if raw materials had to be bought at the present rate of exchange. It is not inconceivable that with the present low exchange rate of French money, similar methods of trading will have to be adopted between France and the United States. Direct exchange of goods may have to be resorted to rather than actual buying and selling in dollars and cents.

* * *

AERONAUTICAL EXPOSITION

At the second annual Aeronautical Exposition which will be held at the Seventy-first Regiment Armory, New York City, March 6 to 13, an opportunity will be afforded those interested in aeronautics to see what American designers have accomplished in developing commercial airplanes. While the airplane owes its development principally to the war, American manufacturers have concentrated their efforts on airplanes for pleasure and commercial use since the hostilities ceased. It is expected that the exhibition will represent all the producing airplane factories in the United States. Many of the models to be exhibited have enclosed cabins with reinforced glass windows, and seat from four to twelve passengers in comfortable upholstered chairs. The noise from the motors is deadened, and the passengers are enabled to enjoy a flight much as they would if they rode in a limousine. Several flying boats will also be exhibited. The larger airplanes have a carrying capacity of from 3000 to 6000 pounds and are driven by three or four motors. It is stated by optimistic airplane enthusiasts that the cost of operating airplanes has been reduced during the last year from the almost prohibitive figure of from $1 to $2 a mile, until now it may be compared with motor truck or railroad transportation.

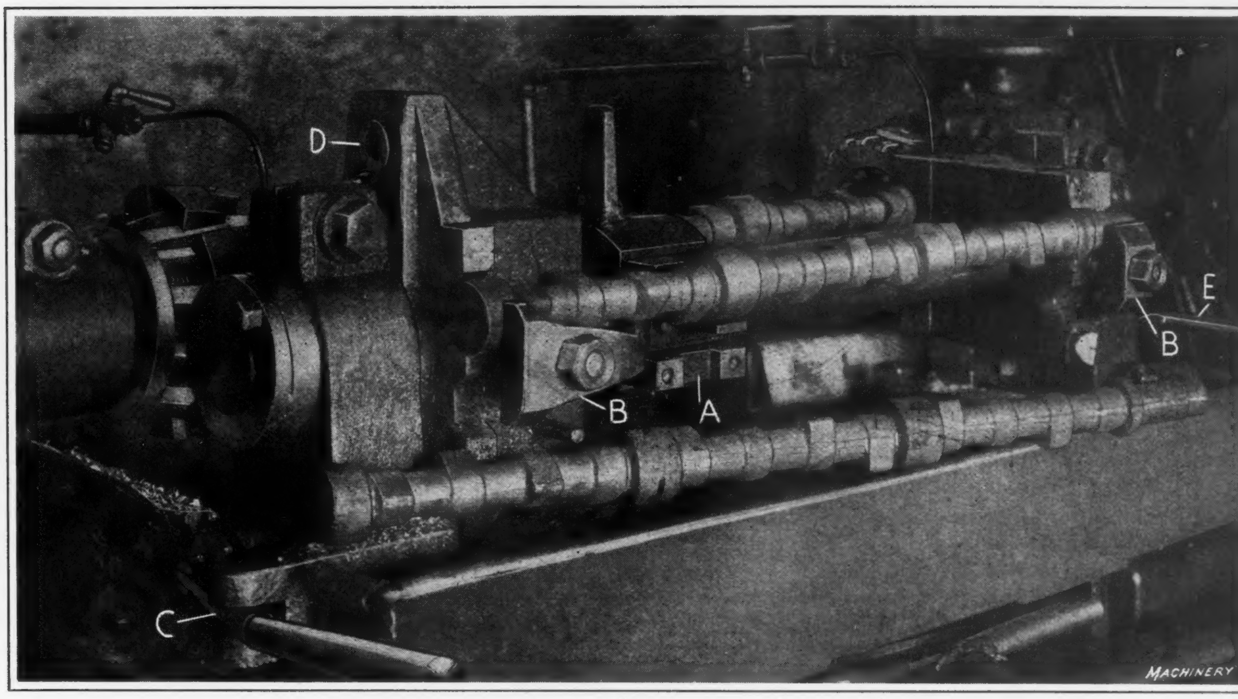


Fig. 1. Indexing Work-holding Fixture for straddle-milling Camshafts

Indexing Milling Fixtures

First of a Series of Three Articles on the Use of Indexing Fixtures for Obtaining Increased Production in Milling Practice

IN setting up milling machines for quantity production there are a number of fundamental principles which must be observed in order to obtain maximum production and quality workmanship. These points are briefly outlined in the following paragraphs, and it is likely that every skilled mechanic will say, after looking over this matter, that nothing in the way of new information has been brought to his attention. Despite this fact, it is entirely probable that an investigation of the condition of milling machines used in the shop where he is employed would reveal the fact that a number of the points mentioned have been overlooked, with the result that there has been a serious reduction in the number of pieces produced per day and in the accuracy of the work. Too much emphasis cannot be laid on the importance of observing all of the following simple and obvious principles.

When making arbors for use on milling machines, do not attempt to use soft machine steel. In order to give satisfactory service, arbors should be made of machine steel and first carburized to increase the carbon content at the surface of the metal. After receiving this treatment, the arbors are hardened, with the result that their entire surface is covered by a skin of hard steel, which protects them from becoming bruised or nicked; at the same time, the inner metal is left soft and tough so that it has ample strength to resist severe shocks. It may be that an arbor is required for immediate use, making it impracticable to take the time for the carburizing operation. In such a case, a fairly satisfactory arbor can be produced from 60-point carbon or chrome-nickel steel. An arbor made of this material is not as good as one made of machine steel and casehardened, because when it is heat-treated the hardness extends all of the way through the steel, and without the tough inner core there is more danger of the arbor breaking.

When setting up a milling machine, the arbor should be put in place in the spindle and carefully tested with a sensitive indicator to make sure that it runs true. It is obvious that if the arbor does not run accurately, a uniform action of the milling cutters cannot be obtained. For the same reason, it is necessary to take great care of the taper hole in the machine spindle. When setting up the arbor, a point should be made of seeing that there are no chips in the spindle socket or adhering to the shank of the arbor. The presence of chips will not only throw the arbor off center, but they will also prevent a close engagement between the arbor shank and the spindle socket, and thus make it impossible to secure the required frictional resistance between the arbor and the milling machine spindle in which it is mounted.

There is some difference of opinion as to the best form of outboard support for a milling machine arbor. It is quite general practice to use a split cylindrical bearing for this purpose, the claim being made by advocates of the straight bearing that if a tapered bearing is used to provide means of adjustment to compensate for wear, the mechanic will in many cases set the bearing too tight, and thus produce a condition that is far worse than would result from the slight amount of lost motion in a cylindrical bearing. This argument is adequately met by advocates of the tapered bearing, however, by stating that a set-up man who has charge of a milling machine department should certainly have the necessary skill and experience to adjust a tapered bearing properly. Dependence cannot be placed upon cold-rolled steel for making keys for securing milling cutters on their arbors. A good grade of key stock should be used for this purpose and the finished keys should be drawn to a spring temper. When the cutters have been set up on an arbor, care should be taken to see that they run true and that all of the teeth do their proper share of the work. Where these conditions are not obtained, accurate work will not be produced and the life of the cutters will be greatly reduced. A full discussion will be presented in a later section of this article, of methods of designing work-holding fixtures, which is a point of equal importance to those just given in regard to cutters and arbors. The information presented on these topics may be summarized by saying that it is absolutely essential for both the cutters and the work to be properly "housed" in order to get the best possible results.

Before leaving this subject, attention should also be called

to the necessity of inspecting the milling machines at specified intervals. If bearings or slides fit badly, or if there is lost motion between feed-screws and their nuts, accurate results cannot be obtained; also, such conditions will adversely affect production, because when a machine which is in poor condition is run at a high speed and heavy feed, there will be a tendency for the cutters and work to chatter. When this kind of trouble is experienced, the natural thing is to slow down the speed and feed in order to eliminate the chattering of the cutters and work; but this also reduces the rate of production secured from the machine. In many cases such a loss could be avoided by making the necessary adjustment of bearings, slides, gibs, etc., on the milling machine.

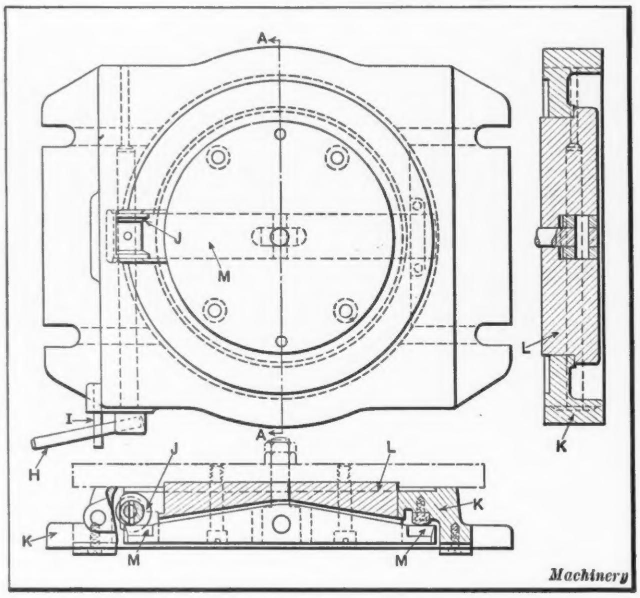


Fig. 2. Plan and Cross-sectional Views of the Standard Type of Indexing Milling Fixture used by the Studebaker Corporation, also shown in the Illustration Fig. 3

General Types of Indexing Fixtures

On small or medium sized machines, it will frequently be found advantageous to make use of indexing fixtures for holding the work. Such fixtures may be designed to carry two or more pieces according to conditions; but the general arrangement is to have two stations, so that the piece or pieces which are mounted in one station may be milled while the operator is removing finished parts from another station and setting up fresh blanks in their place. Then, after milling the parts held in the operating position, the fixture is indexed to bring the blanks which have just been set up into position for milling. The operator then proceeds to remove the freshly milled pieces from the fixture. This sequence of movements can be constantly repeated, with very little loss resulting from idle time of either the machine or its operator.

Many successful modifications of design have been worked out for indexing fixtures that are to be used for holding pieces of work on milling machines. The simplest of these is represented by a case in which provision is made for merely holding two pieces of work, so that the milling operation may be performed on a piece held in one station of the fixture, while the other station is unloaded and a fresh blank set up ready for milling. It is a common practice, however, to arrange indexing fixtures in such a way that two or more parts are mounted at each station, examples of such fixture designs being shown in Figs. 1 to 6, inclusive. Another commonly used type of indexing fixture is that employed for turning pieces of work for successive operations on the different sides, in order to bring the work to a square, hexagon, or some other desired form. Examples of this method of designing indexing fixtures are shown in Figs. 7, 8, and 9. Fixtures of this kind may be made with a number of collets or other means for holding the work; and a gang of cutters may be mounted on the milling machine arbor, one or more of these cutters engaging each piece of work. The work-holding devices and the indexing mechanism of the fixture should preferably be geared together so that turning a single handle provides for simultaneously indexing all of the pieces of work.

Another method of indexing fixture design is that of combining with the indexing principle the features of a string fixture, which tends to increase rates of production. An example of such a design will be shown in the next installment of this article. Such fixtures consist essentially of a plate, carrying two strings of work-holding clamps, which is mounted on a pivot at a point midway between the two ends of the fixture. Not only does such a method of design make it possible to take advantage of the string-fixture principle, but it also avoids practically all the idle time which is involved in unloading and resetting fresh pieces of work before the next operation can be started. After the pieces in one station of the fixture have been milled, the operator simply releases the lock-pin and swings the baseplate around, end for end, so that the string of parts held in the second station of the fixture are brought into the milling position. Then he is able to occupy his time unloading the milled parts and setting up fresh pieces of work, while the milling operation is being performed on those pieces held in the other station.

Still another useful application of the indexing type of fixture can be made for milling parts of small or medium size. This consists of making two duplicate indexing fixtures which are mounted at opposite ends of the table. There are many shops using this method of performing machining operations with very satisfactory results. This method is used where both ends of the work have to be milled. The method of procedure is to first mill one end of the work held in the fixture at the left-hand end of the table and after this has been done, the table is moved over to allow the cutters to start milling the work held by the right-hand fixture. While this cut is being taken, the left-hand fixture is indexed into position for taking a cut at the opposite end of the work held by this fixture. The table is then moved back to take this cut and the right-hand fixture is indexed. While the second cut is being taken on the work held in the right-hand fixture, the finished work is removed from the left-hand fixture and a new piece is set up in its place.

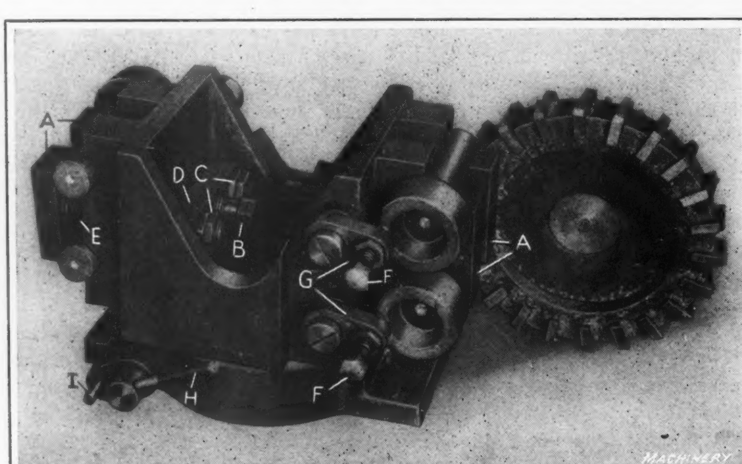


Fig. 3. Indexing Fixture of Standard Design, equipped for holding Transmission Pinion Forgings for milling them to the Specified Length

Standard Design of Indexing Fixture Used in Studebaker Plant

Substantial savings may often be made in the cost of special tool equipment required for the performance of a variety of machining operations by adopting standard tool parts which may be adapted to the requirements of a specified job. A case in point is seen in the

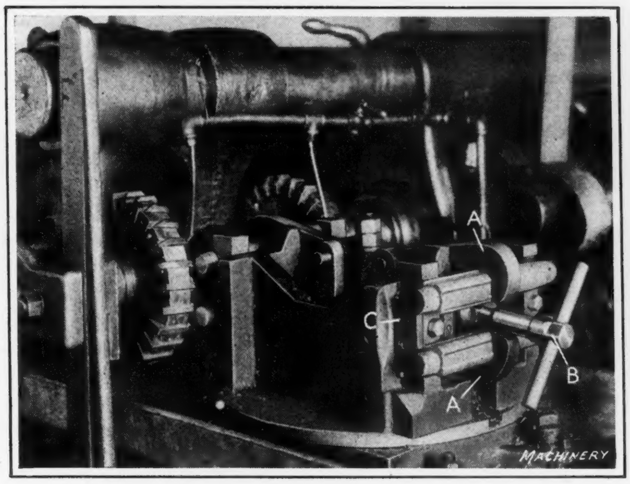


Fig. 4. Milling Machine equipped with Indexing Fixture for straddle-milling Transmission Shafts

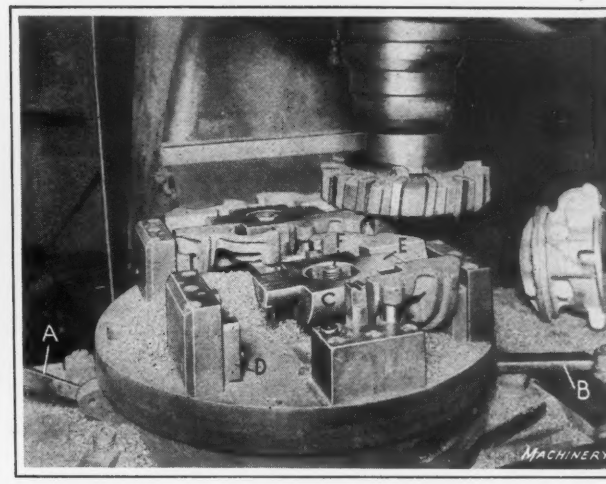


Fig. 5. Vertical Milling Machine equipped with Indexing Fixture for facing Joints of Bearing Caps

indexing milling fixture illustrated in Figs. 2 and 3. The body of this fixture is now used in most cases where an indexing type of work-holding fixture is required for the performance of a milling operation in the Detroit plant of the Studebaker Corporation. Such fixtures are made in quantities, and then when it is required to provide for handling a specific job, it is only necessary for the tool-room to provide, on the body of the fixture, suitable clamps and locating devices for handling the work in question. When a fixture of this type becomes obsolete, it is only necessary to discard the special clamp and locating device. The body of the fixture can be utilized for another job.

As an example of the work which must be done in the toolroom to adapt one of these standard fixtures for the performance of any specified milling operation, attention is directed to Fig. 3, where a fixture is shown that has been arranged to provide for milling off the end of the shank of transmission pinion forgings to provide for reducing them to the required length. Two forgings are set up in the V-blocks on each station of the fixture and held in position by means of straps *A*, which are drawn up by means of a bolt *B*. The two bolts *C* extend through the body of the fixture and are secured to straps *A*. Bolt *B* is threaded through bar *D* and abuts against the wall of the fixture, so that when bolt *B* is tightened it pulls back bar *D* and through the action of bolts *C*, causes straps *A* to clamp the work in the V-blocks. It will be evident that compression springs *E* are placed under straps *A* so that when bolt *B* is loosened, these straps are lifted out of engagement with the work without requiring attention from the operator.

The purpose of this milling operation is to reduce transmission pinion forgings to the required length, and as a result accurate endwise location of the work is a matter of importance. Such location is accomplished by means of two stop-screws *F* which are carried by swinging brackets *G*. In setting up the work, each forging is pushed up into contact with screw *F*, after which bolt *B* is tightened to clamp the two forgings in place ready for milling. The reason for having the end-stop mounted on swinging straps *G* is that a practice is made of only loosening bolt *B* sufficiently to allow the forgings to be drawn through the V-blocks to remove them from the fixture. As the size of the heads on the work makes it necessary to push these pieces through from the end at which stops *F* are located, it is obvious that provision must be made for getting these stops out of the way while the milled pieces are being withdrawn from the V-blocks and fresh forgings set up in their places. On this operation, the milling cutters rotate at a speed of 57½ feet per minute and the work is fed to the cutters at a rate of 1 inch per minute; the production obtained is 200 pinions per hour.

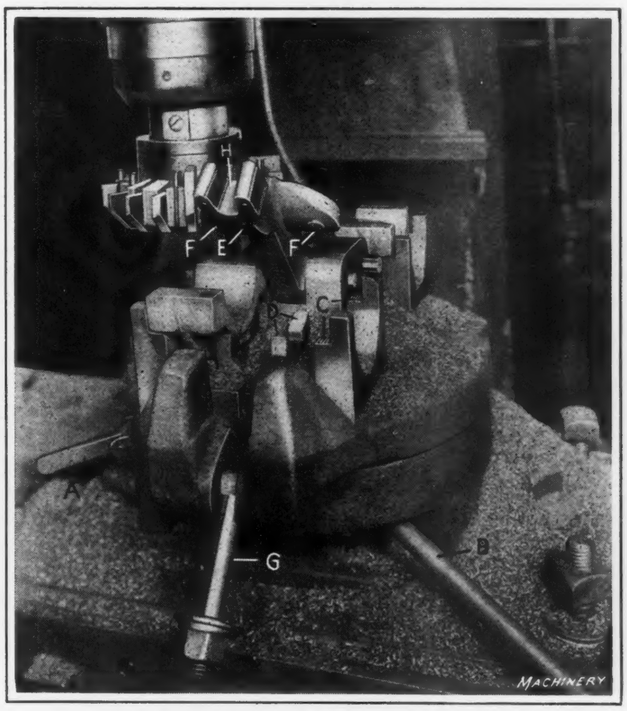


Fig. 6. Vertical Milling Machine equipped with a Special Indexing Fixture for a Similar Job to the One shown in Fig. 5

The important feature of design of the indexing milling fixture which has been adopted as a standard by the Studebaker Corporation is that it is only necessary to manipulate a single handle in order to locate this fixture in either of its two working positions and to lock it in place. Referring to Figs. 2 and 3, it will be seen that this locating and locking of the fixture is accomplished by means of lever *H*. In the position in which the lever is shown in Fig. 3 the fixture is locked; and when it becomes necessary to release the fixture in order to bring the opposite station around into the working position, lever *H* is swung over against pin *I*, after which the fixture may be revolved by hand. When brought to approximately the required position, lever *H* is pushed back, thus obtaining an accurate location of the fixture and locking it in the position so obtained.

A better idea of the way in which this fixture is designed will be obtained by referring to Fig. 2. In this illustration it will be apparent that lever *H* is carried by a cross-shaft on which there is mounted a cam *J* that has eccentric beveled flanges around its ends. The fixture consists of a stationary base *K* and a table *L* which may be indexed to bring the work carried on it into either the milling or the unloading position, as desired. This table *L* has a slot cut in its under side, in which there is mounted a bar *M*, projecting outward at each side, so that it may be engaged by the tapered flanges on cam *J*. Consequently, when an approximate location of the table has been

secured through rotating it by hand, the turning of lever *H* causes cam *J* to be rotated so that the eccentric beveled flanges on this cam engage bar *M* and turn table *L* the slight distance, in either direction, that is required to locate it accurately, after which further turning of cam *J* results in clamping the table firmly in place. It will be apparent from the cross-sectional view that the flanges on cam *J* are cut away at one side, so that when lever *H* is swung over into contact with pin *I*, the cut away section of the cam allows the table to be rotated for indexing. Then when lever *H* is swung in the opposite direction, the flanges on the cam come into engagement with the bar *M*, locating and locking it in the manner just described.

Straddle-milling Transmission Main Shafts to Length

Fig. 4 shows a Becker-Brainard No. 4 milling machine equipped with one of the standard indexing fixtures used by the Studebaker Corporation, which has been adapted for straddle-milling transmission main shafts to length. It will be apparent from this illustration that two forgings are mounted on each station of the fixture, and that these forgings are held by V-blocks, in which they are secured by means of hooks *A*, that are tightened on the work by turning a socket wrench *B*. This socket wrench turns a screw which pushes back a rocker link located inside of the fixture, that, in turn, is connected to the rear ends of the two hooks *A*. When this rocker link is manipulated through the screw turned by socket wrench *B* it pulls hooks *A* back on the forgings and draws them into their seats in the V-blocks. A sufficiently accurate location of the work may be obtained from the end of one of the splines on each forging, which is brought into engagement with a locating plate *C*. The remainder of this fixture is of standard design, so that it calls for no further description. In the performance of this operation, the rate of production obtained is 135 transmission shafts per hour.

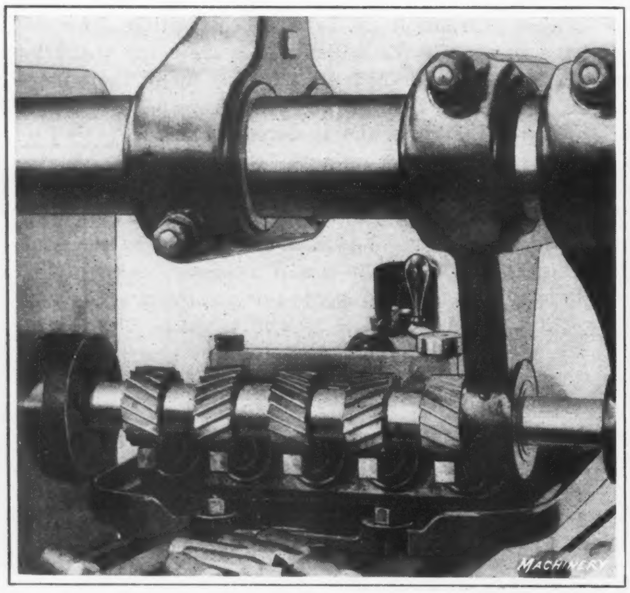


Fig. 7. Milling Machine equipped with Indexing Fixture for simultaneously milling the Sides of Five Square Piercing Punches. Details of this Fixture are shown in Fig. 9

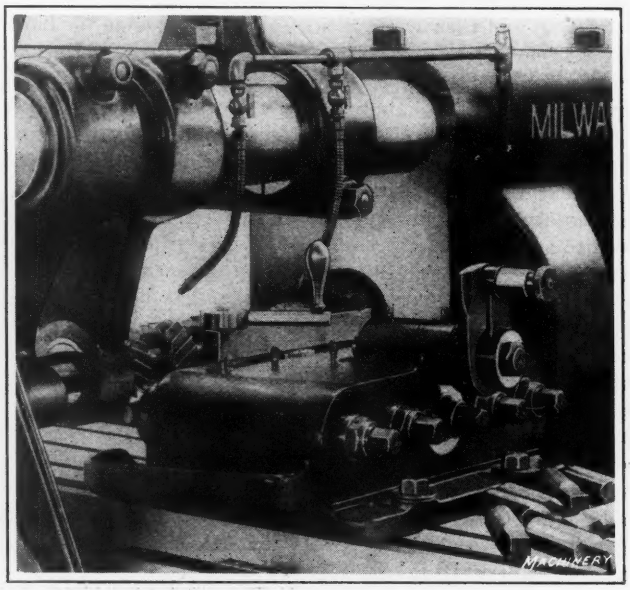


Fig. 8. Opposite Side of Work-holding Fixture shown in Fig. 7, showing the Single Crank for indexing the Work and Individual Bolts for operating the Collet Chucks

Straddle-milling Camshafts to Length

The first operation performed on camshaft forgings as they come to the machine shop of the Studebaker Corporation is to straddle-mill them to the specified length. This operation is performed on a duplex milling machine built by the Becker Milling Machine Co., of Hyde Park, Mass., which is shown in Fig. 1. This machine is equipped with an indexing fixture of different design from the standard type used by this company. In this case, it will be apparent that two forgings are held in each station of the fixture, one of the forgings having been removed from the V-blocks at the front and laid on the bed of the machine, in order to show the fixture more clearly. Endwise location of the work is accomplished by means of gages *A* which fit over one of the bearings on the camshaft. It will be evident that at both ends of the fixture there are straps *B* which hold the two forgings back into their V-blocks. At each end of the fixture there is a lever. Lever *C* at the left-hand end is employed to pull a locking pin which slides through holes located at 180 degrees from each other, one of these holes being shown at *D*. Lever *E* at the opposite end of the fixture is used to manipulate a tapered index-pin, that is depended upon to locate hole *D* in accurate line with the locking pin, so that this pin may always find its way "home." About the only exceptional feature of this equipment, aside from those already mentioned, is that it was necessary to build an extension at the right-hand end of the milling machine bed in order to enable the required spacing to be secured between the cutters. As in the case of all operations where forgings have to be milled, a practice is made of delivering a copious flow of coolant to the cutters. The rate of production obtained is 50 camshafts per hour.

Special Indexing Fixtures

Figs. 5 and 6 illustrate the use of two indexing fixtures at the Studebaker plant, which are of different design from the standard form used by this company. It will be seen that both of these fixtures are employed for the performance of face-milling operations on cast-iron crankshaft bearing caps. Both of these operations are performed on Model C vertical milling machines built by the Becker Milling Machine Co. Instead of having a single lever which provides for locating and locking the milling fixture in either of the two available positions, it is necessary to manipulate two levers in order to accomplish these results. On both of these fixtures, lever *A* manipulates a tapered pin which provides for locating the fixture in exactly the desired position; and after this has been done, lever *B* is swung over to bring an eccentric binder into action, which provides for locking the fixture in place ready for performing the milling operation.

Attention can now be directed to the means provided on the fixture shown in Fig. 5 for locating and clamping the bearing cap castings in place. In setting up the work in both of these fixtures, an arrangement of supporting points is provided, which constitutes the equivalent of the three-point suspension used for holding large sized castings on planer type milling machines. On the fixture shown in Fig. 5, each casting is supported by means of two fixed points, one of which is shown at *C*, and by two points on a pivoted block *D*. Owing to the way in which block *D* floats, it is able to adjust itself for slight variations in the size and shape of

the castings so that assurance is obtained that both of the supporting points at the top of block *D* will come into engagement with the work. Were it not for having this block mounted on a pivotal support, there would be considerable probability of the work being supported by means of the two points *C* and one of the points at the top of block *D*.

After two of the castings to be milled have been set up on the supporting points on one station of the fixture, a half round strap *E* is dropped into place in the bearing grooves in the two pieces of work, and the clamping nut is tightened down on screw *F* to secure these two castings in place. During the time that the castings are being set up on one station of the fixture, the other two castings in the second station are being milled; and when the milling operation has been completed, the fixture is indexed to bring the two fresh castings into the operating position. On this operation, the material is cast iron, and so no cutting oil or coolant is necessary. The rate of production obtained is 40 bearing caps per hour.

Fig. 6 shows a fixture of somewhat different design from the one shown in the preceding illustration, which is used for milling a smaller size of crankshaft bearing caps. A statement has already been made that the method of indexing and clamping these two fixtures is the same. In the fixture shown in Fig. 6, each of the castings that is set up in one of the stations on the fixture is carried by two knurled shoulders *C* and a V-block *D*, the arrangement constituting the equivalent of the three-point suspension used for supporting pieces of work for the performance of a first operation. After the castings have been dropped into place, strap *E* is tightened down in order that the two knurled points *F*, which are provided on this strap, may come into contact with the top of the work and provide for holding it down on the suspension points. To secure strap *E* down on the work, a pivoted bolt *G* is swung up into place in the slot *H*, after which the nut is tightened on bolt *G* to hold the strap down. The slot provided to receive bolt *G* makes it unnecessary to do more than loosen the nut in order to remove the work from this fixture. In the performance of this operation, the pieces of work are smaller than those shown in the preceding illustration, as a result of which the rate of production obtained is twice as high, or 80 bearing caps per hour.

Indexing Fixture which Governs Form of Work

The term "indexing" is quite generally understood to imply the rotation of the work through part of a turn, in order to provide for taking the next cut, as, for instance, cutting the next tooth of a gear blank or for milling the next side of a square or other shaped piece of work. In any case, the indexing principle of fixture design as so employed is responsible for the final form to which the piece is milled. In Figs. 7, 8, and 9 there is shown an indexing fixture of this kind. The pieces to be milled are piercing punches which are required to be square in shape, with a 5-degree clearance extending back from the cutting edges. Four milling operations are performed with the work indexed through an angle of 90 degrees between successive operations, in order to obtain the square end for these punches; and by having the milling fixture tilted at an angle of 5 degrees, provision is made for obtaining the necessary clearance behind the cutting edges. On this operation, the material being milled is tool steel, and a liberal amount of coolant is delivered to the milling cutters and work, in order to prevent overheating. The double-arm Milwaukee milling machine built by the Kearney & Trecker Co., Milwaukee, Wis., on which this operation is performed, is used at the plant of the Portsmouth Steel Co., Portsmouth, Ohio, for making punches that are used to pierce the spike holes in railroad tie-plates. The punches are 3/4 inch square, and are made from 1 1/2-inch round bar stock.

A better idea of the design of the work-holding fixture will be gathered from Fig. 9, which illustrates the mechanism that is provided for tightening the four collets in which the work is held, and for indexing the work to take four successive cuts that are required to complete the milling of these punches. It will be seen that each of the four piercing punches *A*, which are set up to be milled in this fixture, are carried by split collets *B* which are closed on the work by means of screws *C* at the back of the fixture. Each of these collets is manipulated independently by means of a wrench that fits over the square end of the screw. After the work has been secured in the collets, the milling operation is started, so that the first of the square sides is produced on the work. Then the milling machine table is backed away, and index lever *D* is turned through one revolution. This motion is carried to the collets by spur gears having a ratio of 1 to 4, so that one complete turn of handle *D* results in rotating the work through 90 degrees. The collets are then locked in this position, after which the feed mechanism of the milling machine is engaged to provide for finishing the second of the square sides. By repeating this indexing and milling operation four times, the square ends of the punches are completely formed.

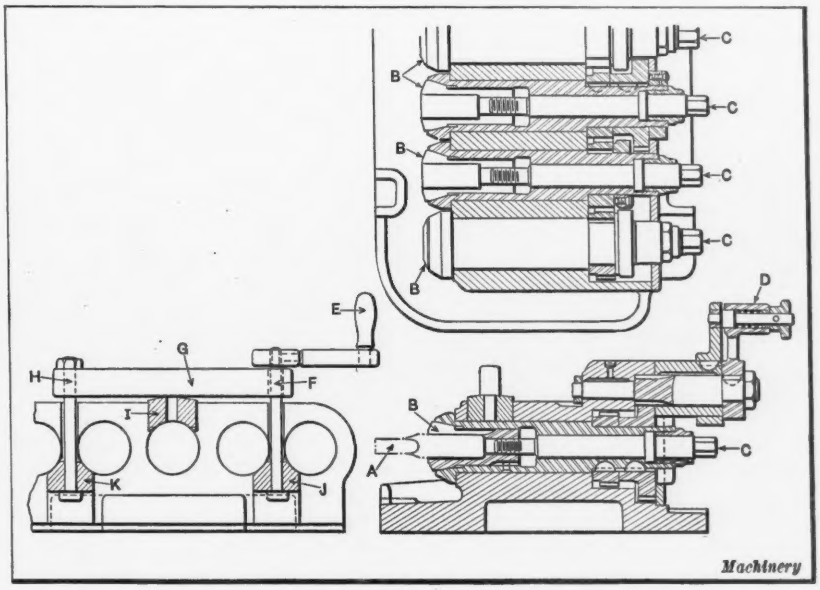


Fig. 9. Sectional Views of Indexing Work-holding Fixture shown on the Machine in Figs. 7 and 8

The clamping of the collets for the performance of each successive operation is accomplished by means of crank handle *E*. It will be seen that this handle is secured at the top of the screw *F*, which passes through a hole in one end of bar *G*. At the opposite end, this bar is held by a bolt *H*. Bar *G* is supported by a fulcrum *I*, that is formed by the top of a sliding block, the under side of which bears against the top of the central one of the five collets. At the lower end of bolt *F* there is a shoe *J* which is formed to engage the under sides of two other collets, and a similar shoe *K* at the opposite end of the fixture engages the under side of the two remaining collets. It will be quite evident from the illustration that turning crank handle *E* results in screwing the threaded hub of this handle down on bolt *F*, causing bar *G* to swing on its fulcrum. The first effect of turning lever *E* is to screw the threaded end of this lever down on bolt *F*, and, as pressure is exerted, shoe *J* is pulled up between two of the collets, thus locking them in place. Similarly, downward pressure is provided on shoe *I* for locking the third collet, and the tendency for bar *G* to swing over this fulcrum causes shoe *K* to be drawn upward, thus locking the two remaining collets.

Sale of Business and Good-Will

By CHESLA C. SHERLOCK

THERE is no business custom presenting legal complications that involves so many problems as the sale of a business and the good-will of the sellers. Business men have always assumed that upon the sale of the good-will of a business, the seller binds himself not to engage in the same business again in the same locality. This assumption seems to have been the outgrowth of an erroneous conception of the meaning of the term in its legal significance and to pure ignorance of the law. It is also due to a change in the attitude of the courts toward the subject, which has contributed in no small degree to the existing confusion. The courts at one time took the view that if a business man sold his business and the good-will thereof, he also sold his right to re-engage in the same business in the same locality, but recent decisions have materially broadened this conception. In more remote times, the courts were unfamiliar with the term, as it had not come into the usages of business. The practice of the sale of good-will is of comparatively modern origin and may be said to have been an outgrowth of modern business methods, taking cognizance of the rigors of competition and of effort, upon the purchase of a business, to remove the seller from the field of competition.

Definition of Good-will

Lord Eldon, an early English authority, defined good-will as "the probability that old customers will resort to the old place." Lord Hatherly, a more recent English authority, gives the following definition, as embracing the modern view of good-will: "Good-will . . . must mean every advantage—affirmative advantage if I may express it, as contrasted with negative advantage of vendor not carrying on the business himself—that has been acquired by the old firm by carrying on its business, everything connected with the premises, or the name of the firm, and everything connected with or carrying with it the benefit of the business." Construed in a liberal sense, this definition would seem to preclude the seller of the business from further engaging in a competing business, but the American courts, at least, do not go that far in their construction of the matter.

Court Decisions on Rights Transferred by Sale of Good-will

It has been established as a general rule in recent decisions in Iowa, Massachusetts, Missouri, Nebraska, New Jersey, New York, Ohio, Tennessee, Texas, and Ontario, that in the absence of an express covenant, the sale of a business together with the good-will thereof, does not impart an agreement by the seller not to engage again in a competing business. In a Texas case, it was shown that a salesman who had been a representative of a number of dealers and manufacturers in an exclusive territory for a number of years, had assigned his agency with the good-will of the business to a corporation of which he became manager. Shortly after the deal was transacted he was deposed from his position in the corporation and the corporation sought to enjoin him from again representing the dealers and manufacturers he had previously represented and from handling their goods in the same territory. In this case the court held that the assignee could not be enjoined from representing these dealers and manufacturers so long as he did not solicit their business or attempt to induce the old customers from doing further business with the corporation.

In an Ontario case, it was held that the partner in a manufacturing company who sold his interest in the business, might engage in the business of manufacturing a similar product, the ingredients of which were the same as those of the old firm, provided they were compounded differently; and so long as he did not use the secret formulas of the old firm, he was not debarred from engaging in a similar business, and from using the usual methods of doing that business, even though it involved use of knowledge gained as a partner.

In an Iowa case, it was held that the seller of a mail-order business is not subject to an injunction by the purchaser enjoining him from engaging in a similar business 200 miles from the former place of business. It was shown in this case that the seller had used advertising methods similar to those he had formerly used and that he had continued to conduct his new business in precisely the same manner that he had the old one, using the same name and methods. The court hinted that the damage thereby caused to the purchaser undoubtedly gave him a cause for action, but that since there was nothing in the evidence to show the amount or extent of such damage, the court was powerless to act on that score.

In a Massachusetts case, it was held that one who sold all right, title, and interest in a fire and casualty insurance business was not precluded from engaging in the same business, or from using her own name or that of her father, the former owner, in conducting it. In Nebraska, a stock of merchandise was sold together with the good-will, and it was held that such sale does not imply an agreement that the seller would not re-engage in the same business again in the same town. In Tennessee, it was held that the sale of the good-will of a business and no more did not preclude the seller from setting up in precisely the same business in the same city, or even in the same vicinity; and that the only way the purchaser can forestall such a step is to stipulate precisely against it in the contract of sale.

In Massachusetts, the rule has been laid down that a sale of good-will imposes upon the vendor an obligation to refrain from doing anything which deprives the buyer of the benefit and advantages which belong to the business, and if a competing business is set up by the vendor, the question of whether or not an agreement not to compete (where none has been expressed) is to be implied, is a question of fact for the jury to determine.

Infringement of Rights Transferred by Sale of Good-will

It is pointed out that in England the purchaser of good-will gets nothing but the right to keep the vendor from soliciting old customers of the business, while in Massachusetts no competing business can be set up if it derogates from the grant of the good-will of the old business. This distinction is worthy of consideration. It implies, and such implication seems to be found in all cases, that the mere fact that the vendor or seller has engaged in a competing business is not, in itself, ground for an action for damages or for an injunction. The real test of the right of the purchaser for relief lies in the manner and the methods in which the vendor conducts his competing business. He cannot, for instance, treat the old business firm as he would other competitors and use the same means and methods in winning business from it that he could use without restriction in the case of other competitors. He must not do anything to affirmatively win the old trade away from the old business, but in regard to new trade, he seems to have a free and unrestricted hand.

In New York, it was held that where a partner sold his interest in the firm business to his partner and thereafter engaged in a competing business, he should be restrained from attempting to procure the benefit of patterns, the exclu-

sive use of which by the old firm's manufacturers was a valuable asset of the business. This decision was made regardless of the fact that the firm did not have binding agreements with the manufacturers whereby the manufacturers could reserve these patterns for the trade of the old firm. This was held to be an element which entered into the old firm's business with which the retiring partner, by his transfer of his interest in the good-will, had bound himself impliedly not to interfere.

Use of Firm Name

The question of whether the vendor of a business and the good-will thereof can establish a competing business under his own name, which happens to be the same or identical with the old firm name, is a matter which has caused no little attention from the courts. Business men have always asserted that they have the right to use their own name in their business, and they have further asserted it to be a fundamental right of a man to use his own name, even in case he has sold the good-will of a business bearing that name.

Purchasers, on the other hand, often contend that if the vendor of a business starts a competing business under the same name or under one similar to that of the old firm, then he is not dealing fairly toward the purchasers in respect to the trade of the customers of the old firm. And there seems to be a great deal of truth in this contention. For, if a man associated with a business uses a similar name, it seems that it will be conducive in itself to the deception of old customers and lead them to believe that he has either reorganized or changed his location. If this is true, then he has no right to do it, for he is not giving the old firm every affirmative advantage it is entitled to in respect to the old customers that he has conveyed to the old firm in the grant of the good-will.

In a Federal case, it was held that an individual cannot be prevented from carrying on business in his own name, and that a purchase of the good-will of a business carried on in the name of an individual will not, as a general rule, prevent that individual from carrying on business in his own name thereafter, but in such cases the courts usually require that the later business shall be carried on in such a way as not to produce confusion with the business of which the good-will has been sold. In this particular case the firm name adopted by the vendor when he established a competing business was the same as that of the old company with the simple addition of the word "Sons" before "Company." The court held that the purchaser was entitled to an injunction restraining the new firm from soliciting business from old customers and from simulating letter or bill heads, and papers of the former corporation, and further held that the new firm should either change its name, or else change its place of doing business.

Good-will in Case of Involuntary Sale

Another phase of the matter is presented in cases where the sale has been involuntary, as in bankruptcy proceedings and the vendor has been forced, often against his will, to part with the good-will of the old business. The question then arises: Does the purchaser of good-will under such circumstances acquire the same rights he acquires where the sale has been voluntary and for a consideration? In New York, the court said: "The good-will which the owner thereof parts with in *invitum*, as in bankruptcy proceedings or by operation of law, as in the liquidation of a partnership by lapse of time or its termination pursuant to the articles of agreement, is a lesser property than the good-will which is the subject of a voluntary sale and transfer by the owner for a valuable consideration. In the first class of cases, the former owner remains under no legal obligation restricting competition on his part in the slightest degree; in the second class of cases, the former owner, by his voluntary act of sale, has excluded himself from competing with the purchaser of the good-will to the extent of having impliedly agreed that he will not solicit trade from customers of the old business. To this extent this good-will is a more valuable property than the good-will of a business which goes to a trustee in bankruptcy, or a receiver or survivor of a partnership in liquidation."

In England, it was said: "There is no question as to the general principle that if a man sells the good-will of his business to a purchaser and receives the purchase money, he cannot afterward destroy that which he has sold by soliciting his old customers, but that principle has never been extended to any case except that of a sale, or of some construction equivalent to a sale." Good-will has come to be recognized by the courts as a valuable trade asset, and while there formerly was a struggle over this contention, all question as to its reasonableness seems to have passed. It is a trade asset in one sense, but it is well to keep in mind that it cannot be disposed of independently of the other assets of the firm.

When and how Good-will may be Transferred

Good-will must always follow the other tangible assets and the seller cannot separate it from such assets and convey it to another party independent of them, although he may reserve it to himself while conveying the assets to other parties. As to when good-will exists, there is some contention. Many courts have said that where a monopoly is enjoyed and there has been no competition that there is no good-will, but this cannot be taken too literally or difficulties will arise on all sides. It cannot be said, where the good-will involves the sale of patents and trade-marks as the tangible assets, that no good-will exists, even though a monopoly was enjoyed. While good-will may be sold and transferred as an incident to the business, it cannot be reached by a creditor's bill, and it is well settled that a stockholder in a corporation has no interest in the good-will of the corporation sufficient to make it the subject of sale. Partners cannot sell the good-will of the partnership unless every partner joins in the conveyance, although a partner may assign or sell his own *interest* in said good-will, either to the surviving partners or to other persons, provided he is not restricted by the partnership agreement.

Where the contract of sale of a business fails to mention the good-will thereof, it is presumed by the courts that it was intended to follow the other tangible assets of the business, and there is no presumption that it was reserved by the seller. Good-will is reserved to the seller only when expressly so stipulated in the contract of sale, and the purchaser of the business acquiring the good-will along with the other assets can prevent the seller setting up a new business only when he has expressly so stipulated in the contract of sale. Infringing on the conveyance or grant of good-will consists of the use of any method on the part of the seller which threatens to destroy the property which he has granted to another by his conveyance. He cannot engage in *unfair competition* with the old firm, which means that he cannot attempt to hold or win back the old customers by deceit, artifice, or direct solicitation on his own part.

There are two remedies open to the purchaser of a good-will which has been infringed. They are either an action to recover payment for damages to the amount of the injury caused by such infringement, or an injunction to prevent a continuance of such unfair methods. In the case of damages, the purchaser must be able to state a specific amount of damage caused by the infringement and prove it. When an injunction is granted no sum is awarded for damage, the seller merely being stopped from further infringement by legal proceedings. Another remedy is sometimes recognized which relates to the specific performance of the contract whereby the seller has agreed to convey the good-will of the business. This remedy is not, however, as effective as those previously mentioned. The general legal principles involved, as explained above, may prove of value particularly to men who are more closely in touch with mechanical problems than with business procedure.

Carburizing and Casehardening

Second of a Series of Articles Describing Methods of Carburizing, Determining Depth of Carburization, Protecting Portions of Work in Local Carburizing, and Cleaning of Carburizers After Use

By S. P. ROCKWELL
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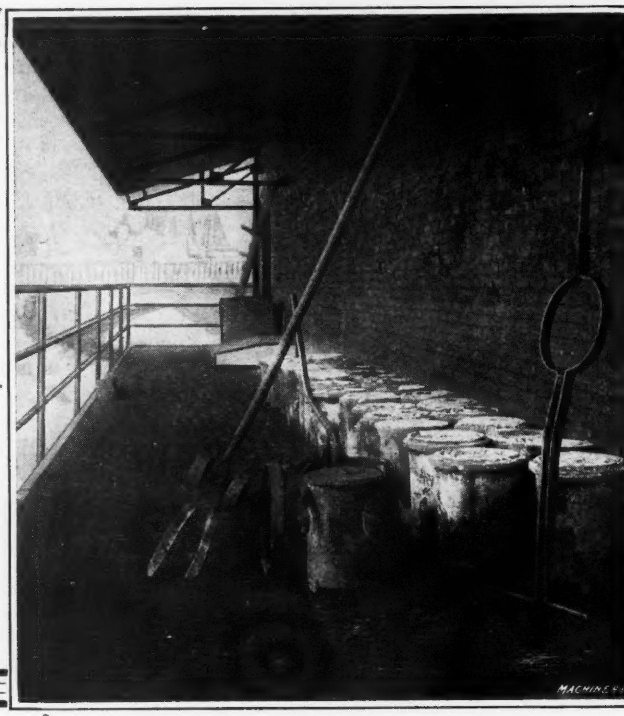


THE temperatures used in universal practice for carburizing vary greatly. It is customary to find temperatures ranging from 1400 to 1900 degrees F., and every firm will give valid reasons why the temperature used is the best. Examination of these reasons usually shows that the degree of heat used is based either on the furnace operation or production. Some furnaces, due to their construction and fuel, are unable to produce high temperatures, and of this order are notably the old type of coal-fired furnaces. Lack of furnace space in relation to the amount of work often forces the operator to raise the temperature higher than good work calls for, in order to enable him to keep up production. Sometimes no regard is given to variable temperatures in the furnace during the period of carburization. It is, of course, impossible to entirely eliminate variable temperatures in different parts of a furnace, especially in large furnaces. The proper design of furnace and kind of material used in its construction will, however, reduce this trouble to a minimum. It is readily seen that considerable temperature variation in the different parts of the furnace will directly affect the depth of penetration of carbon in the work, and likewise the amount of carbon or percentage of intensity. This is due to the fact that steel is more susceptible to carbon penetration at high temperatures than at low temperatures, and also because the amount of carbon in the carburizing gases varies with the temperature.

Importance of Constant Temperatures

Variable temperatures during the carburizing operations should be avoided for the following reasons: (1) The furnace lining is subjected to unnecessary strain by cooling and heating. (2) It is difficult to keep track of the progress of the carburizing operations. (3) The steel is subjected to various intensities of carbon in the carburizing gases which make a non-uniform case. (4) The dangers of enfoliation or separation of the carbon into layers are increased. (5) The carburizing material is strained at the high temperatures and will give off so much gas that its efficiency at the lower temperatures will be impaired, and hence the variable temperature seriously interferes with the results.

There are, of course, certain classes of work on which hardness is the only thing desired, and where accurate control of the furnace temperature is not always necessary. For the general class of work, however, it will be found that uniformity of temperature is wise, as it will save in many ways, and will tend to eliminate mental vexation of the hardeners.

When deciding what temperature to use for carburizing, the following factors must be considered: Depth of penetration, carburizing material, size of pot, and class of work. Other points which have some bearing are the steel, furnaces, fuel, and production.

Factors Influencing Carburizing Temperature

Depth of Penetration—The man in charge of the heat-treatment should know to what depth the work is to be carburized. Experience is of the greatest value in determining this, not necessarily experience with other identical parts, but with parts bearing similar relationship as regards strain, shock, and wearing qualities. For work requiring a slight depth of 1/32 inch and less, low temperatures of from 1450 to 1550 degrees F. are perhaps advantageous if the carburizing material is not considered. The reasons for this are that initial penetrations take less time than final penetration; in other words, each succeeding 1/64 inch of penetration takes a longer time than the preceding 1/64 inch. The low temperatures allow the operator to regulate the depth with greater exactness, and for parts of small cross-section this close control is vital, as high temperatures cause the depth to go beyond that desired before the work can be removed from the furnace. High temperatures for slight depth work will cause pots to lag in heat from the outside to the center, the result being great uneveness in the depth of carburization between the outer and center pieces. For work requiring a depth of from 1/32 to 1/8 inch, a temperature range of from 1550 to 1650 degrees F. is desirable, as this will allow sufficient control of the latter part of the penetration, and the heat lag from the outside to the center of the pot will be negligible. For work requiring a depth of 1/8 inch and over, a temperature range of from 1650 to 1750 degrees F. will answer the purpose. There are very few instances where it is wise to use a temperature in excess of 1750 degrees F., as the steel becomes porous from the extreme grain size and the carbon intensifies on the surface, forming free cementite or freckled edges. The extreme grain and free cementite are only removed with difficulty by subsequent heat-treatment, so that what is saved in time in the carburizing is lost by the time and cost of restoring the damage done.

Carburizing Material—Bone, leather, and commercial carburizers containing these products in a great part as a base are most efficient up to 1550 degrees F. Beyond this point they rapidly lose their efficiency and after a few hours of use they become dead. Bone has a total life of about ten

TABLE 4. DEPTHS AND PERCENTAGES OF CARBON ON WORK TREATED BY VARIOUS CARBURIZERS AT DIFFERENT HEATS AND TEMPERATURES

Kind of Carburizer and Temperature of Heat in Degrees F.	Length of Heat, Hours	Depth of Carburization in Inches of Layers Containing Different Percentages of Carbon			Total Depth of Carburization, Inch
		More than 0.9 Per Cent	0.8 to 0.9 Per Cent Inclusive	Less than 0.8 Per Cent	
Bone, 1600......	5	0.0066	0.0066	0.0192	0.0324
	10	0.0030	0.0144	0.0190	0.0364
Bone, 1750......	5	0.0126	0.0180	0.0216	0.0522
	10	0	0	0.0612	0.0612
Oil Hydrocarbon, 1600..........	5	0.0012	0.0072	0.0174	0.0258
	10	0.0090	0.0120	0.0280	0.0490
Oil Hydrocarbon, 1750..........	5	0.0144	0.0168	0.0235	0.0547
	10	0.0252	0.0252	0.0384	0.0888
Chemical, 1600..	5	0.0084	0.0108	0.0216	0.0408
	10	0.0025	0.0144	0.0300	0.0469
Chemical, 1750..	5	0.0230	0.0145	0.0276	0.0651
	10	0.0250	0.0169	0.0540	0.0959

Machinery

hours at 1600 degrees F. at which time it will become completely exhausted. Other commercial carburizers containing charcoal, coke, and coal as generators, and chemical and oil hydrocarbons as energizers should be used at temperatures of from 1500 to 1750 degrees F., the best efficiency being obtained at about 1600 degrees F. Granular or pellet carburizers are liable to be burned to ash by the use of too high temperatures, especially if the sealing of the pot is poor and allows the entrance of the oxygen of the air. This would result in exposed work which would be spoiled by decarburization and oxidation. For low temperatures, the size of the pot is immaterial except for slight-depth work. For combinations of high temperatures and slight depth, the smaller the pot, the better; otherwise, the lag of the heat from the outside to the center of the pot will over-carburize the work near the outside before the work at the center has started to carburize. As a general rule, small pots are to be desired for high temperatures, especially for slight-depth work. For low temperatures, the same holds true to a less degree.

In commercial practice, as a rule, no annealing precedes the final machining operations. Because of this, the work, when received for carburizing, contains mechanical strains that are relieved by heat and cause warpage during the carburizing operations. The higher the temperature, the more readily the strains are removed; further, the higher the temperature, the greater the work expands and the greater the grain size becomes, while distortion and warpage are more likely to occur. This is especially true with fluctuating heat. Where large grinding tolerances are left on the work after final machining, the warpage of the work is secondary, but for delicate fixtures having a great variety of cross-section sizes, low temperatures will give by far the best results. Alloy steels will, as a rule, stand more abuse in heating than straight carbon steels, inasmuch as alloy steels are denser and the grain size is less liable to be abnormally increased, which helps to decrease distortion.

Where furnaces are uncertain in their operation, so that it is hard to hold the temperatures uniform, the low temperatures are safest. Such furnaces and their operation, however, should be investigated, as such conditions should not exist. The operation of the burning apparatus should at all times be controlled to give a combustion of gases slightly rich, as lean or dry combustion gases contain an excessive amount of air, which retards carburization, scales the pots, etc. A low temperature is usually richer in carburizing gases than a high temperature. High sulphur fuels are always harmful to steel in a heated condition, and the higher the temperature, the greater the danger. In carburizing, this is not important except from a fuel cost standpoint, as the gases generated by the carburizer are in excess of the furnace gases, and there is at all times a slightly greater pressure within the pot than in the furnace, which prevents the sulphur from coming in contact with the work. Heavy production and inadequate facilities force shops to use high temperatures for carburizing. When this occurs, extra care should be taken to guard against unforeseen happenings, as the high temperature may be close to the danger point. At the end of the increased production period, lower temperatures should be used so as to increase the factor of safety even though no apparent harm has resulted.

Determination of Carburization Depth

No special rules can be given for determining the depth of carburization required for different articles. This can only be determined by experience, so the hardener and the designing engineer should be consulted when deciding this. They should know what shock or strain the work is to be subjected to, and if the strain is great and the cross-section of the part is comparatively small, their decision will undoubtedly be to give a slight depth. If, however, the work has a large cross-sectional area and the strains are not very great, a greater depth may be allowable. The question of the amount of surface to be removed by grinding, as a result of warpage, shrinkage, and expansion of the work, will govern the minimum depth of carburizing. It would be undesirable, of course, to grind through the case at any point due to a high spot caused by warpage.

The desirable carbon case contains from 0.8 to 0.9 per cent carbon. The longer the heat and the higher the temperature, the higher the percentage of carbon becomes on the surface of the work. If the work requires grinding after carburizing and hardening and the high carbon is ground off to the zone containing from 0.8 to 0.9 per cent carbon, best results can be obtained and great-depth carburizing can be done. If, however, the work is not ground after carburizing and hardening, slight-depth carburizing is safest, unless care is taken in the selection of the carburizer and in the heat-treatment after carburizing.

Table 4 shows the depths and percentages of carbon in work exposed to three kinds of carburizers for five- and ten-hour heats at two different temperatures. This table gives the depths of various layers containing different percentages of carbon and also the entire depth of carburization. These figures were obtained by microscopic examination, and for such an examination the work should be cooled in the carburizing pot, sawed in two pieces, polished, etched with a 10 per cent solution of nitric acid in alcohol, and then examined under about 100 diameters, which will allow the total penetration of the different layers to be distinguished. The layer containing more than 0.9 per cent carbon had free cementite and pearlite; the layer containing from 0.8 to 0.9 per cent consisted of pearlite, and the layer having less than 0.8 per cent consisted of pearlite and ferrite. It will be noted that, in several instances, long heats at high temperatures caused zones of less measurement than shorter heats at lower temperatures. This was especially true when bone was used, as that material played out and lost its ability to give high amounts of carbon during long heats at high temperatures. A close study of this table will give an idea of the carburizer and the temperature to use for certain variables of high percentages of surface carbon and total depths.

Such parts as gears, cams, and gages are usually carburized to a depth of about 1/32 inch. Greater depths of about 1/16 inch are used for ball bearings, arbors, plug gages, etc., while depths up to ½ inch are used on large sizes of ball bearings. The reason for this is that the load is supported on a very small area and the shell must be heavy enough to prevent a small section of it from pushing into the core. Greater depth than this is limited to armor plate, etc. It is expensive to carburize work of great depth, and when the depth is more than ⅜ inch it will be found more economical to use tool steel.

Observation of Carburization Progress

It is usually necessary to control the depth of carburizing operations closely, and as the depth is affected by the carburizing material, temperature of the pot, length of the heat, and method of packing and sealing, it is necessary to have some knowledge of the progress of this work. There are a number of ways of doing this, but if the work is small and the cost of the individual pieces trifling, the most satisfactory way is to remove a piece from the pot, let it cool in the air, reheat it to about 1450 degrees F., quench in water, and break to judge the depth of case. When no previous experience has been had in this work or when a new carburizer or heat is being used, or other conditions vary, it would be well to break specimens at stated intervals of time and plot from them a rough time penetration curve. This will give an approximate idea of how long it will take to carburize to a given depth. However, there are so many conditions entering into the carburizing operations, such as, for instance, the operation of furnaces on different days under varying weather conditions, that it is impossible to judge the depth of carburization accurately for a stated number of hours. It is best to take a sample from the pot after it has been carburized for three-quarters of the time shown by the penetration chart and break it as described above. From observing this sample and by comparison with the chart, it will be possible to determine if the work is ahead of or behind the schedule. From this sample a very close approximation can be made as to when to complete the heat. The charts shown in Figs. 3 and 4 in the article published in the January number of MACHINERY will be found of assistance in making up the chart just described.

In the charts just referred to, Curves 1, 2, 3 indicate how it is possible to be mistaken as to the depth of carburization for various lengths of time. A study of these charts will show that the apparent depths secured vary according to the method of depth examination and the shape of the work. Polishing and etching or bluing will show the depth approximately right, because the acid or heat acts only on the higher carbon of the case, whereas, a rough fracture will indicate a deeper carburization. Round rods carburize deeper per unit of time than rectangular rods, and both carburize deeper than concave surfaces. This is due to the fact that convex surfaces fill up more rapidly with carbon than concave surfaces, because with the concave surfaces, the carbon, after it has entered the work has to spread out to cover more case area.

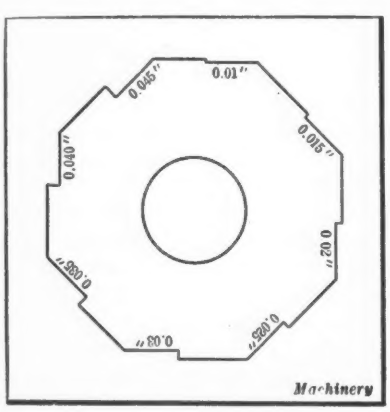


Fig. 8. Octagonal Scale for measuring Depth of Case on Hardened Work

If it should be considered too costly to break a sample for testing purposes, it would be well to put into the pot some of the scrap pieces of steel from which the work is made. These steel pieces could be attached to wires which would reach up under the cover so that they could be readily reached and removed, or better still, holes could be drilled through the cover of the pot and some of the same steel in rod form could be stuck through the cover into the pot, so that it could be withdrawn at any time. Such pieces are called "tell-tale" pieces and can be used in determining the depth of the operation at different times, and if placed in different positions in the pot can be used to tell the rate at which the pot is heating up, by comparing the color of the "tell-tale," immediately after withdrawal from the pot, with the color of the pot or the furnace. In this way, it is possible to tell whether or not the inside of the pot has the same temperature as the furnace. All carburizing operations should be tested from the time that the pot has reached the temperature of the operation, inasmuch as some concerns charge their furnaces when cold and others when heated. The difference in the sizes of the pots and the form of material, that is whether it is granular or powdered, cause a great variation in the time required to bring the pot to the desired temperature. After this has been reached, the rate of carburization is equal, regardless of the form of material or size of the pots, provided the materials are of the same chemical composition and the pots are sealed equally.

Observation of Carburization by Quenching Sample Piece Directly from Pot

Another method of determining the depth of the carburization is by quenching the sample piece directly from the pot in either oil or water. If oil is used, it should be carefully wiped from the piece before the fracture is made, or the oil will discolor the fracture and give misleading results. Although this is quite a good method, it is not as good as the method previously explained, due to the fact that the grain of the case and core is coarse and very nearly of the same crystalline size, which makes it hard to note the line of demarcation. However, if this method is used, and the piece is held in front of the fire and tempered to a slightly blue color, it will be found that the high carbon of the case will take on the temper colors more rapidly than the low carbon of the core and the result will be that the case will show up a deep blue, while the center of the core will be a straw color. For the same purpose the sample could be immersed in a 10 per cent solution of nitric acid, after which the case would appear much darker than the core. The previous method of reheating to 1450 degrees F. and quenching in water, gives a better and truer idea of the actual conditions which have taken place and shows results that may be expected in the finished product.

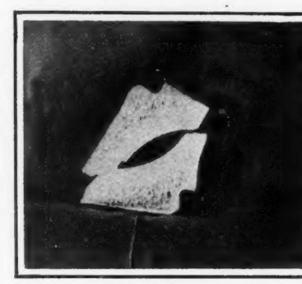


Fig. 9. Section of Ball Races showing Appearance of Hardened Surface

If the seal or luting of the pot is broken when the test samples are removed, the pot should be luted up again before being put back into the furnace, or else the rate of carburization in that pot may be retarded, and if the same pot is tested again, it may not be representative of the rest of the pots in the heat. It is well, if there is a variation of temperature in the furnaces, to take the test samples from a pot which has an average temperature. Fig. 8 shows an octagonal disk which may be used for measuring the depth of case. The edges of this disk are notched for this purpose, the depth of the notch being given in each instance.

Value of Local Carburizing

Local carburizing, or the process of carburizing only those areas which are to be increased in carbon content so as to obtain the desired hardness while the remainder is left soft, is one of the most valuable features of the carburizing process. The following are some of the products on which this treatment is invaluable: (1) Ball bearing races, on which a deep backing of soft metal is desired for strength and toughness while the surface in contact with the ball is extremely hard. Fig. 9 shows two ball races cut in half on which the depth of the case can be readily seen. (2) Carburized taps and drills, where production precludes handling the parts separately in the hardening operation, in order to keep from heating and quenching the shanks. (3) Delicate tools or gages on which the thickness of the metal would be carburized clear through and thus cause brittleness. (4) Work which distorts in hardening and must be reshaped by machining or bending, such as arbor shafts, camshafts, etc.

Methods of Preventing Carburization of Certain Portions of the Work

There are numerous ways of preventing portions of the work from being exposed to the carbon-carrying gases. The

sections that are to be kept free from an increase in carbon may be covered with fireclay mixed with water to the consistency of putty, then dried by moderately slow heat, and finally packed in the pots with a carburizer in the ordinary manner. Drying before packing is usually necessary because when the water in the fireclay is exposed to the high heat of the carburizing furnace it will cause the fireclay to crack, permitting the carburizing gases to enter the fissures thus made and cause partial carburization. Salt is often mixed with the fireclay, which lowers its fusing temperature and acts as a binder. After carburizing in the usual manner, the clay is cracked off and the work treated in the hardening operation the same as carburized work. This method is successful for small shops where the demand for local carburizing is not great.

The metal protecting sleeve is especially practical where the form of the work warrants its use. This method consists of slipping a sleeve or collar over the part required to be free from an increase of carbon. The sleeve is either a push or loose fit, and if the latter, it can be wired in place. If the sleeve is too loose, the carburizing gases will enter between the sleeve and the work, but this may be satisfactorily avoided by daubing a thin mixture of fireclay on the inside of the sleeve before putting it on the work. After carburizing, the work may be hardened in the regular way either with the sleeve left on or removed. Leaving the sleeve on insures softness of the covered section, but if the sleeve fits on the work too tightly, trouble may be experienced in its subsequent removal, due to shrinkage. The sleeve may be of iron or steel and can be made in sections for ease in applying, in which case the sections may be wired together and covered with fireclay at the joints, or it may be cut away as the work demands.

Asbestos is often used in local carburizing by wrapping it around the section desired to be kept free from an increase in carbon and binding it in place with bundling wire. Sand can be used for the same purpose by placing it in the bottom of the pot and imbedding in it the section of the part desired to be kept free from an increase in carbon, permitting the section to be carburized to extend above it and be packed with carburizing material in the regular way. This method is usually not desirable because the sand becomes mixed with the carburizing material, and with the iron scale which accumulated from the pots, will eventually form glass or silicate deposits on the work.

A thin paste of water glass (sodium silicate) and kaolin (a fine grade of clay) is often painted on sections of the work that are to be kept free from an increase in carbon. Used sand-blast sand in a finely divided state is often mixed with this. This mixture is dried on the work by air, after which the work is packed in pots in the regular way. Local carburizing is also effected by the application of a compound called "enamelite," which is applied and used in the same manner as the preceding preparation. These various methods are more efficient for slight-depth than for great-depth carburization. The skill of the operator in applying them affects the final results. In carburizing to great depths, the long heat eventually breaks the protection, and penetration of the carbon results, the sand method being probably the only exception. An excellent and sure method of keeping a desired section free from hardening is to leave sufficient metal on the sections that are to be soft and then after carburizing and hardening, this excess metal can be machined from the piece. It is evident that more time will be required by this method and the cost will be greater.

Local Carburization by the Copper-plating Method

The most satisfactory method of local carburizing, when the volume of the work warrants it, is the copper-plating method. It is well known that it is impossible to harden copper by heat-treatment, because carbon is the chief hardening element in metals, and there is no affinity between copper and carbon. The copper is plated on the work by the electroplating process. A coating of copper sulphate is unsatisfactory, as there is no bond between the steel and the copper coating, and because of this, the coating will peel off under certain conditions, such as too heavy a copper coating, lack of density, or different expansions of copper and iron due to heat. The copper electroplating process consists of chemically cleaning the work, copper electroplating it, and then mechanically removing the copper at the parts that are desired to be hardened. The process of mechanically removing the copper also removes some of the steel, so it is necessary to have a sufficient allowance of metal to be removed. The copper may be ground or machined off, but the former method is unsatisfactory, as minute particles of copper are replaced and imbedded by the wheel in the surface to be hardened, thus giving to the hardened finished surface a semi-softness that is often puzzling as well as serious. The following is an actual occurrence:

A certain concern making airplane engines experienced trouble in getting sufficient hardness on the cams of camshafts. Their method was to copper-plate the shaft and cams and then grind off the copper on the surface of the cams. The fault was laid to the carburizer, and various commercial grades of materials were experimented with, but no improvement resulted. The writer investigated the trouble and with the aid of a magnifying glass, noted tiny specks of copper on the surface of the cams. One of these cams was then heated to a cherry red and quenched in oil, which brought out the copper very plainly. The copper appeared as yellow specks while the steel had turned black. The grinding wheel was examined next, and its surface was found to be full of copper, so it was assumed that the wheel removed the copper in small particles and replaced some of these particles by imbedding them in the soft steel. The effect, when carburized, was that there were small soft spots which had been protected from the carburizing gases so that the hardened work was a mosaic of minute hard and soft spots which could be filed.

Japanning the Portion of the Work to be Carburized

In order to eliminate mechanical removal of the copper, japanning of the surface desired to be carburized is often resorted to before copper-plating. After baking the japan on, the work is plated, but the copper does not adhere to the japanned portion. The japan burns off in the carburizing process, and the steel formerly covered by the japan becomes carburized. The following method is used by a large concern doing local carburizing, the work being protected by electro-copper-plating. The grease is first removed from the work by cleaning with sal soda or gasoline, according to the amount of grease, after which the work is thoroughly cleaned by washing successively in potash, hydrochloric acid, cold water, potash, cold water, cyanide solution, cold water, and finally hot water. The work is then covered with two coats of japan, being baked at 400 degrees F. after each coating. The same routine of washing is then gone through as before, but omitting the hot water. The work is then placed in a cyanide copper solution for ten or fifteen seconds, or until a copper color is barely obtained. This solution is kept lukewarm and used with electric current of about 5 volts. The formula for this solution is as follows: 50 gallons of water; 25 pounds of copper carbonate; and 50 pounds of cyanide of potassium (or enough to bring the carbonate into solution). The solution is kept at from 8 to 10 degrees Baumé. After the work is thoroughly rinsed in cold water, it is transferred to a nickel-plating bath, used with a current of about 3 volts and having a scant anode surface. The bath is not allowed to become hot, and the work is plated for from ten to fifteen minutes to give a good foundation. The work is again rinsed thoroughly in cold water and transferred to a cold acid copper solution, used with a current of 5 volts, in which it is plated for twenty or thirty minutes. The formula for this solution is to add to 50 gallons of water enough copper sulphate to give a reading of 18 degrees Baumé, and enough sulphuric acid to give a reading of from 20 to 22 degrees Baumé, care being taken to keep the acidity and specific gravity correct. The work is then washed in cold water, hot water, and finally dried.

The ability of the plate to resist the action of carburizing materials does not depend upon the thickness—from 0.001 to 0.0015 inch is sufficient for any purpose—but on foundation and density. The cleaning before and after japanning, keeping the solution cool enough, and the density of the plate, are the important factors in electroplating. The nickel-plate might be omitted in some cases, but it eliminates the necessity of the work remaining a long time in the cyanide-copper solution and the consequent effect on the japan and steel. It also gives a good foundation which is resistant to the action of the acid copper solution. The method of plating just described is used for work requiring over a hundred hours of carburizing and is very satisfactory.

Importance of Taking Proper Care of Carburizing Material

The carburizing operation often meets with a lack of success and this is due, in the majority of cases, to not taking proper care of the carburizing material. This material should be considered as important as the furnace, any piece of machinery throughout the factory, or the cutting lubricants used for machining purposes. During the use of the carburizing material, it is giving off gases, a certain proportion of which are absorbed by the steel. A greater proportion, however, is lost through the sealing or luting of the pots. It is impossible to prevent this loss unless the carburizing is done under pressure, and then such a pressure could be generated as to blow the pot apart unless some type of safety valve were arranged. This is not practical for the shop, and is therefore only a laboratory proposition. In consequence, with the release of the carburizing gases, there must be a deterioration of the material.

Methods of Cleaning Carburizers

All material, whether in pellet or powder form, is made up of distinct particles. In the pellet form they are the pellets themselves but in the powder form these particles are very small in size. When the pots are cooled before the covers or luting is removed the deterioration of the material will take place by a shrinkage of the particles, either through throwing off the gases or by a surface loss. In either case a certain amount of ash is formed which is a dead material and must be removed before the material can be used again; with pellet materials, the natural handling, through dumping of the work, will cause this ash to fall away from the pellets, and it can readily be separated by sifting. This ash may be of a dust nature, or it may consist of small granules. As the latter is often true, it is best to sift this material through a fairly coarse mesh. This sifting will remove all the dust and a considerable proportion of the smaller pellets which possibly would have become dust themselves before the end of the next heat, and would clog the circulation of the heat-conducting gases. For this purpose the ordinary fly screen netting is very satisfactory.

With a pellet material there should be enough space between the pellets to allow the gases generated at the outside of the pot to circulate through to the center. Therefore the dust not only is dead material and takes away the strength from the whole, but it also clogs up these spaces between the pellets and prevents the proper circulation of the gases. For the same reason too small pellets are not desirable in a pellet material.

With a powder material, this circulation of heat-conducting gases throughout the pot is not as perfect as with the pellet material. The heat is conducted throughout the pot by conductivity, and the dust which is generated through the use of the small particles merely weakens the strength of the whole. It is impracticable, of course, to sift such a material. It will also be found that as this material packs denser in the pot and the space between each particle becomes minute, air will not readily be conveyed into these spaces, and in consequence the loss due to the dead dust will not be as great as with a pellet or granular material. The particles, however, will continue to become smaller and make the contents slightly more dense. It will be found, also, that dead dust will be generated on the surface of the pot to varying degrees of depth, due to greater exposure to air and furnace gases, and it is therefore the usual practice to discard a certain amount of the surface layer of this material, usually from about one-third to one-fifth of the total volume.

When work is quenched directly from the pot and the carburizer is subjected to the air, it will be found that due to the greater exposure to the air, the material will be subjected to a greater strain than by keeping sealed in the pot. The particles will dust and shrink more, and with a pellet material, sifting should be very carefully done, while with a powder material, more material should be discarded from the surface of the pile than was discarded when the work was cooled in the pot. In most materials the remainder is of approximately the same carburizing strength as when it was first used, except, of course, in the case of materials that employ as an energizer chemicals which are regenerated by air exposure, and also materials that are regenerated by hydrocarbon oils. It is more satisfactory, and usually the custom, to add to this material enough new material to make up the original volume used. If this system of sifting the old material and adding enough new material after the first heat to make up the original volume is followed, it will be found that the carburizing material after a second heat, will begin to approach a constant carburizing strength and give uniform results. There are, however, some materials which are exceptions, and which will be mentioned in a subsequent article.

Often the carburizing material is dumped directly into either oil or water with the work when hot. When dumped into oil, this material will usually have added strength. The material should be removed, drained, and then before being used again, mixed with a like amount of dry material. If more than 50 per cent of this mixture is material that has been dumped in oil, it will be found that more smoke will be given off into the furnace than the flues can take care of. As this material has more strength than new material, due to the hydrocarbons of the oil, it has been found practical to mix the two together. The correct proportions can be determined after a few experiments, and then if conducted properly each time, uniform results will be obtained. When the material is dumped in water it is neither harmed nor improved. It should be dried thoroughly, sifted, and then mixed with new materials as if it had been cooled in the pot or subjected to the air.

* * *

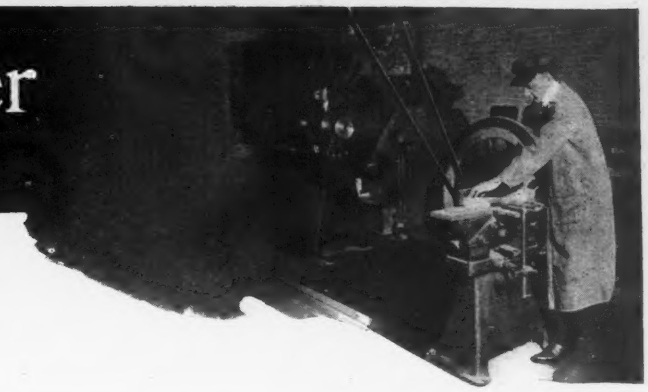
HEATING MOLDING PRESSES FOR BAKELITE

Steelclad electric heaters have been employed successfully for the heating of molding machines used in the manufacture of bakelite products, and it has been found that the superiority of electric heat over steam is very pronounced. The saving in rejected material contributes in a large measure to the success of the electric heaters used for this purpose. One of the newest applications consists in applying steelclad heaters to molding machines used in the manufacture of radiator caps for automobiles. A single press will mold sixteen radiator caps at one time, each press being equipped with eight steelclad heaters rated at 625 watts each. With a machine thus equipped, the production is increased sixteen times over the former method, and the percentage of rejections is reduced to a minimum.

* * *

When a steel article having a metallic coating is scratched or abraded so that a small area is exposed, the two metals, in the presence of atmospheric moisture, will form a galvanic couple, or cells, in which a current will be set up. The metal which is electro-positive relative to the other will be oxidized while the electro-negative metal will remain uncorroded. When the coating is zinc, the zinc will be oxidized. If, however, the coating is made from tin, which is electro-negative to iron, the steel will be attacked by rust; hence, tin as a protective coating is useful only as long as the coating remains everywhere continuous.

Pattern Lumber



By Joseph A. Shelly

THE best lumber for patterns, or in fact for any other purpose, is always cut from mature trees, the fibers of which have become compact through the drying of the sap as well as the external pressure exerted by the bark. For this reason, wide boards are invariably superior to the narrow ones that are milled from immature trees.

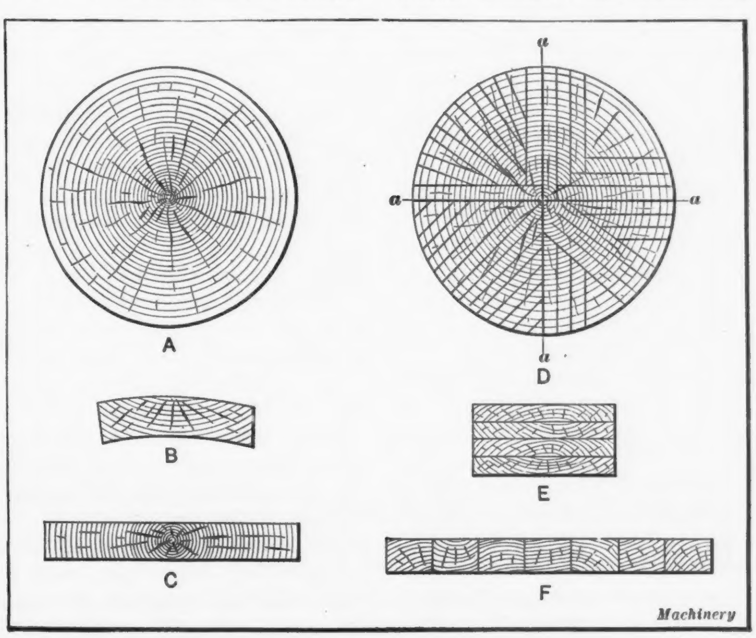
A section of a log (see sketch *A*) on examination will disclose a series of concentric rings extending from the center of the log to the outside. These are called year or "growth" rings, and as one is added each year that the tree lives, its age can be determined by counting these rings. The variations in the amount of each year's growth can also be noted by the varying spaces between these rings. Radiating from the center of the log, and extending to the outside in broken lines, are what are known as the medullary or silver rays. The "heart wood" is that which lies nearest the center of the log; it is darker in color and superior in quality to the "sap wood" which lies directly inside of the bark.

Varieties of Lumber Used in Pattern Work

Many different varieties of lumber have been used in pattern work, and some of them possess admirable characteristics. Of the softer woods, white pine, white wood, poplar, Washington fir, and red wood, are the most common varieties. The list of harder woods used for this purpose includes mahogany, baywood, cherry, maple, and birch. Of the softer woods, all of those mentioned, except white pine, are too easily affected by atmospheric changes to be entirely satisfactory. They shrink and swell, warp and twist; and red wood is one of the few woods that shrinks lengthwise or with the grain. Mahogany is preferable among the list of harder woods, with baywood and cherry next in order. Maple and birch are well suited for small turned patterns but are too hard to be worked economically with hand tools.

The Ideal Pattern Lumber

An ideal pattern lumber should be fairly soft and straight-grained without being splintery. It should be porous enough to take glue well, allowing it to soak into the fibers of the wood in order to make strong glue joints, and when properly seasoned it should not change its form much with exposure to heat, cold, or dampness. White or "cork" pine, as it is sometimes called from the appearance of the bark, is the only lumber that comes anywhere near filling the above requirements. It is easily the best lumber for all but the smallest patterns, being easy to work and durable enough to stand a considerable amount of hard usage. It may be procured in wide boards of considerable length and of different thicknesses. It shrinks but little across the grain, has no perceptible shrinkage lengthwise, and is porous enough to take glue well.



(A) Section of Log showing Growth Rings. (B) Warped Lumber. (C) Quarter-sawn Lumber. (D) Method of obtaining Quarter-sawn Lumber. (E and F) Pieces joined so as to offset the Effects of Shrinkage

Selecting Pattern Lumber

In selecting pattern lumber, care should be exercised to use only those boards that are dry, straight-grained and free from loose knots and excessive sap wood or worm holes. A board, however, should not be condemned if its appearance is marred by a few small tight knots, or a little sap wood at the edges, or even a few worm holes, as these are often found in lumber of good quality.

Kiln-dried lumber is lumber in which the seasoning or drying process is hastened by placing the boards in an oven or kiln. Seasoned or air-dried lumber is lumber that is permitted to dry naturally under sheds so arranged as to have a free circulation of air in good weather. Seasoned lumber is superior to kiln-dried lumber, as the rapid drying destroys much of the natural elasticity of the fibers of the wood, making them brittle and harder to work. The dryness of a board is determined largely by its weight and "feel." A dry board will feel dry to the hand and be reasonably light in weight.

The weights in pounds of various kinds of woods (commercially known as dry timber) per foot-board measure are as follows: White pine, 1.98; Spanish mahogany, 4.42; Honduras mahogany, 3; poplar, 3.25; Washington fir, 2.65; cedar, 1.93; California spruce, 2.08; cherry, 3.5; maple, 4.08.

The straightness of grain in a board is determined by the appearance of the sawn face which should present a uniform roughness over its entire surface. Boards with a twisted or fancy grain should always be avoided.

The presence of an unusual amount of pitch in a board is betrayed by its weight which will be excessive. Such a board will prove hard to work and will not make a dependable pattern. Sap is easily detected, as it will stand out on the surface in small sticky or resinous globules. The sap wood along the edges of the board will either show white or have a brownish tinge.

Sizes of Sawn Lumber

Lumber is the result of sawing trunks of trees into boards or planks that are usually cut to even feet in length and to inches in width. The thicknesses

start at one inch and advance by quarter-inch increments. Pieces less than 1¾ inches thick are called boards and the thicker pieces, planks, while those 4 inches and over in thickness are known as timber.

Lumber that is planed is said to be "dressed" and it may be dressed on one or both sides or edges. A 1-inch board dressed on both sides will be ⅞ inch in thickness. Resawn lumber is sawn again from the mill sizes in order to save stock. For example, a 1¼-inch board may be split lengthwise and planed or dressed on both sides to ½ inch instead of planing two 1-inch boards to the same thickness.

Straight- and Quarter-sawn Lumber

There are two general methods followed in sawing a log into boards or planks: One is known either as straight, bastard, or tangent sawing; and the other is called quarter-sawing. In straight sawing the log is put through the saw without regard to the relation between the longitudinal fibers and the year rings (see sketch *B*), while in quarter-sawing the log is split radially as shown at *C*. The section of year rings on the end of a quarter-sawn board will stand very nearly at right angles to the face of the board. This effect is secured by sawing the log in quarters on the lines *a-a* (see sketch *D*) and then dividing three quarters by one of the methods indicated.

Shrinkage of Lumber

A log in drying does not reduce in diameter as a result of the shrinkage that follows. This shrinkage is always in the direction of the year rings and results in the longitudinal cracks or checks that appear in telegraph and other poles. These checks are radial and follow the lines of the medullary rays as well as the line of least resistance, and occur always on the side of the log that is the shortest distance from the heart. They do not run in straight lines, as a rule, but follow the longitudinal growth of the tree, which is slightly spiral in direction. This is the reason why the grain on two sides of a board will always run in opposite directions.

The effect of shrinkage on straight- and quarter-sawn boards is quite different, as may be seen by reference to the sections *B* and *C* of the accompanying illustration. The straight-sawn board, owing to the shortening of the sections of year rings by shrinkage, becomes concaved on one side and convexed on the other, the convexed side always being the one that faced the heart of the tree. This shrinkage does not affect the face of the quarter-sawn board at all, except on thick pieces which will in time become slightly thinner on the edges. Quarter-sawn lumber is, therefore, the best for light pattern work, but the cost would be too great for its general use in patterns of large size, so the skillful patternmaker who understands the effects of shrinkage will so combine the various pieces that go into a pattern as to minimize, or if possible, eliminate the undesirable results caused by shrinkage. Examples illustrating how pieces are put together to offset the effects of shrinkage are shown at *E* and *F*. Section *E* shows four pieces combined with the grain arranged to counteract the shrinkage strains, while *F* is a standard method of arranging the grain in narrow pieces combined to form wide boards or plates.

Storing and Measuring Lumber

Lumber is usually piled on the flat side with three or four strips about a half inch thick between each board to insure a free circulation of air. This is perhaps the best plan for storing lumber in quantities, as the weight of the pile tends to hold the boards straight. The different thicknesses should be kept in separate piles and the storage room should be dry, warm, and light. Lumber for immediate use should be placed on edge in racks where boards of any size can be conveniently removed without disturbing an entire pile.

Boards are usually sold at a certain price per hundred (C) feet or per thousand (M) feet; the price is usually quoted by the M feet. A board foot measures 12 by 12 by 1 inch in thickness. To quickly measure boards 1 inch thick, multiply the length in feet by the width in inches and divide by 12; the result will be the board measure in feet. If the boards are 1¼ inches thick, add one-quarter of the quotient to the result, or if 1½ inches, add one-half. For boards 2 inches thick divide by 6, or if 3 inches thick divide by 4, etc.

Life of Wood Patterns

The length of time that a wood pattern will last, and the number of castings that can be made from it, will depend entirely on how, and of what materials, it was made in the first place, and on the amount of care given it later on. Patterns that are in constant use should be returned at intervals to the pattern shop for repairs or for revarnishing if no repairs are required. Aside from a certain amount of wear and tear due to carelessness or abuse, there are a number of legitimate reasons for causing patterns to wear out when in constant use. The vent rod which is plunged through the cope of the mold to provide outlet for the gases is usually allowed to strike the pattern and results in pockmarking the cope side; and the practice of driving large nails into the cope side of parted patterns to prevent their falling out when the cope is lifted away results, in time, in making a large hole that must be filled up. Failure on the part of the pattern shop to provide suitable means for rapping and drawing is very damaging, as the molder is likely to use a sledgehammer and crowbar as a substitute for rapping and lifting plates. In every foundry there should be someone whose business it is to take care of the patterns when the molder finishes with them, as permitting a pattern to lie for hours on a pile of wet sand or in the gangway, usually results in a badly twisted or burned pattern. Hard wood patterns will, of course, last longer than those of softer wood if given the same care; large patterns made of soft wood are often reinforced with hard wood corners and loose pieces or are faced with hard wood on the cope and drag sides.

* * *

THE "TECHNOLOGY PLAN" OF THE MASSACHUSETTS INSTITUTE

The new plan of the Massachusetts Institute of Technology for selling services to industry in definite contract form is attracting considerable attention in the business world. Among the forty odd corporations which have signed contracts with the institute are the following concerns: The American International Corporation, E. B. Badger & Sons, Utah Copper Co., Goodyear Tire & Rubber Co., Pierce-Arrow Motor Car Co., Lackawanna Steel Co., Stone & Webster Affiliated Co.'s, Stone & Webster, U. S. Rubber Co., and U. S. Smelting and Refining Co. The "Technology plan" is, in substance, that industrial organizations shall retain, consult, and work with the Massachusetts Institute of Technology under a contract which will bring them into the closest association with the institution—that is, in the future the institute is to be a technical consulting bureau as well as a technical school. Certain advantages which will accrue to the industries are obvious. A scientific library unsurpassed in the world will be available, with experienced men to guide the reader in finding the knowledge sought. Special apparatus and machinery, with assistants familiar with its operation and use, will be found of the greatest aid in the technical development of new ideas. A classified list of graduates and former students, with their experience and major qualifications, will be a real help to those seeking the solution of special problems or the way out of a difficult technical situation. A knowledge of the particular facilities of commercial laboratories and engineering offices throughout the country will be accumulated and placed at the disposal of the corporations in readily usable form. While many factors contributed to the commercial supremacy of Germany before the war, none was more potent than the close cooperation between the individual manufacturing concern and the scientific institutions of learning. The contract proposed will bring about this close relationship between the Institute of Technology and the manufacturers.

INSPECTION OF TAPERED PLUGS

By V. E. AYRE

The inspection of a single tapered plug may be made by taking micrometer readings over two wires of equal size, the top wires being placed on equal stacks of size blocks, and the lower wires on the same surface that the plug rests on.

Let

T = taper per inch established by two diameters at a given distance apart;

C = amount to be subtracted from the micrometer readings in order to determine the actual diameters of the plug at the small end and at the same distance from its base as the height L of the surfaces on which the wires are resting.

Referring to the diagram Fig. 1,

a = angle of taper;

M = greater micrometer reading over wires;

m = smaller micrometer reading over wires;

G = diameter of wires; g = corresponding radius.

Then

$$T = \frac{M - m}{L} \qquad \tan a = \frac{T}{2}$$

$$X = g \cot \tfrac{1}{2}\ (90 \text{ degrees} - a)$$

$$\begin{aligned} C &= 2g + 2X = G + 2X \\ &= G + 2g \cot \tfrac{1}{2}\ (90 \text{ degrees} - a) \\ &= G + G \cot \tfrac{1}{2}\ (90 \text{ degrees} - a) \\ &= G\ [1 + \cot \tfrac{1}{2}\ (90 \text{ degrees} - a)] \end{aligned}$$

The diameter of the plug at the small end and at the height L may be found by subtracting the correction C, from the two measurements taken over the wires; thus

$$d = m - C \qquad D = M - C$$

$$D \text{ (Go)} = D + hT \qquad D \text{ (Not Go)} = D + HT$$

If the diameter of the plug is required at a point other than that at which it has already been measured, multiply the distance between the required and the measured diameter by the taper per inch, and either add the product to or subtract it from the measured diameter, according to its location. For example, $W = d + TY$, or $D - TZ$

Chamber Checks with Two Tapers

In inspecting chamber checks containing two tapers, the tapers can be determined in the same way as for a single tapered plug. For each measurement both wires must be at the same height from the base as shown for the measurement m_1, Fig. 2. The wires may rest on equal stacks of size blocks, or anything that is convenient so that the distances of the measurements from the base will be known.

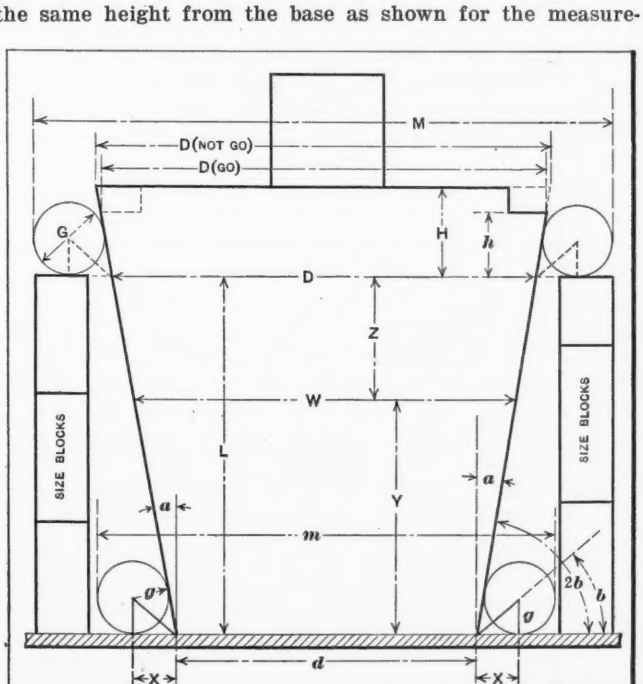


Fig. 1. Diagram used in Connection with Inspection of Single Tapered Plug

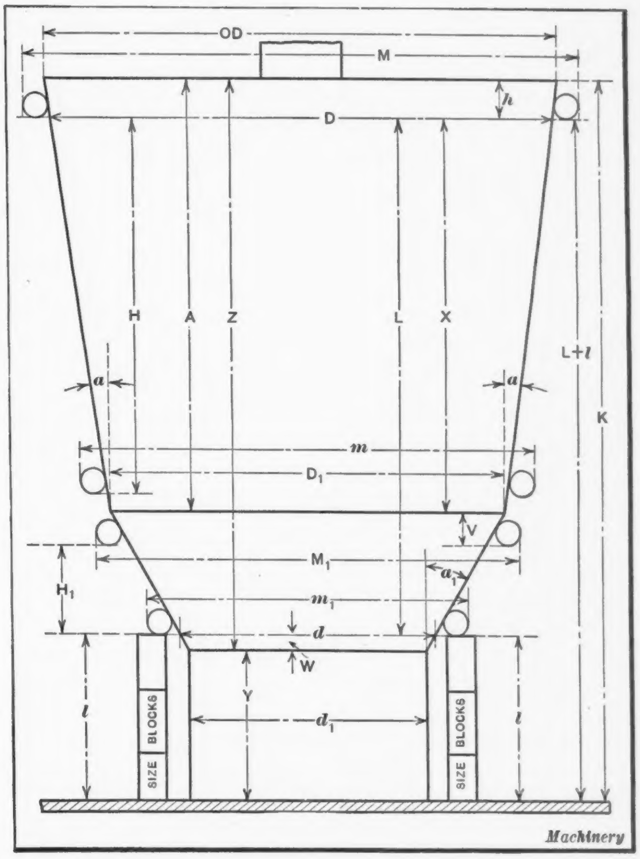


Fig. 2. Method of taking Measurements when inspecting a Double Tapered Chamber Check

Referring to the diagram Fig. 2, the long and short tapers per inch may be expressed by the equations:

$$T = \frac{M - m}{H} \qquad T_1 = \frac{M_1 - m_1}{H_1}$$

$$\tan a = \frac{T}{2} \qquad \tan a_1 = \frac{T_1}{2}$$

The amount to be subtracted from the micrometer readings may be determined from the general formula, as evolved in connection with Fig. 1. $C = G\ [1 + \cot \tfrac{1}{2}\ (90 \text{ degrees} - a)]$ = correction for taper T; $C_1 = G\ [1 + \cot \tfrac{1}{2}\ (90 \text{ degrees} - a_1)]$ = correction for taper T_1, in which G equals the diameter of the measuring wires.

The diameters which are being calculated may be expressed in the following manner:

$D = M - C$ = diameter of plug at height $(L + l)$

$d = m_1 - C_1$ = diameter of plug at height l

To find A, the distance from the point of intersection of the two tapers to the top of the plug, first find X, the distance from the point of intersection to the measured diameter D. Since L = the distance between the two measured diameters D and d, determined by the difference in height of the stacks of size blocks on which the wires rest when taking the measurements M and m_1, then, by applying the general formula for finding the point of intersection of two tapers as published in the November number of MACHINERY, page 267,

$$X = \frac{LT_1 - (D - d)}{T_1 - T}$$

and

$$A = X + h$$

Now the diameter of the plug at the intersection of the two tapers may be found by either of the formulas:

$$D_1 = d + T_1\ (L - X), \text{ or } D_1 = D - XT$$

and the diameter at the large end of the plug may be found

by the formula:

$$OD = D + hT$$

To find Z—the distance to the large end from the intersection of the short taper and the straight part—first find the distance between the measured diameter d and the diameter at the point of intersection d_1. This distance is expressed as follows:

$$W = \frac{d - d_1}{T_1}$$

$$Y = l - W$$

$$Z = K - Y$$

Practical Application of the Formulas

Assume that the diameter D_1 has been found by the use of the foregoing formulas to be 1.5018 inch. Assume, further, that $l = 0.20$ inch; $l + H_1 = 0.75$ inch; $d_1 = 1.452$ inches; and that the readings over the wires placed at these heights are $m_1 = 1.6488$ inches, and $M_1 = 1.69$ inches.

If the diameter G of the wires is 0.0962 inch, then according to the formula, the taper per inch of the lower taper equals

$$T_1 = \frac{1.6900 - 1.6488}{0.75 - 0.20} = \frac{0.0412}{0.55} = 0.0749 \text{ inch}$$

The angle of taper may be found from the formula:

$$\tan a_1 = \frac{T_1}{2} = \frac{0.0749}{2} = 0.03745$$

$$a_1 = 2 \text{ degrees } 8 \text{ minutes } 49 \text{ seconds}$$

The amount to be subtracted from the micrometer readings in order to determine the actual diameters at the heights of the size blocks which support the wires, is found from the formula:

$$C_1 = G\,[1 + \cot \tfrac{1}{2}\,(90 \text{ degrees} - a_1)]$$
$$= 0.0962\ (1 + \cot 43 \text{ degrees } 55 \text{ minutes } 40 \text{ seconds})$$
$$= 0.0962 \times 2.0381$$
$$= 0.19606 \text{ inch}$$

The diameter at distance l from the small end is, therefore:

$$d = m_1 - C_1 = 1.6488 - 0.19606 = 1.45274 \text{ inch}$$

and in like manner the diameter at distance $l + H_1$ from the small end is

$$M_1 - C_1 = 1.6900 - 0.19606 = 1.49394 \text{ inches}$$

The distances $K - A$ and Y are then determined as follows:

$$K - A = 0.75 + V$$

$$V = \frac{1.5018 - 1.49394}{0.0749} = 0.1049 \text{ inch}$$

Therefore,

$$K - A = 0.75 + 0.1049 = 0.8549 \text{ inch}$$

Also

$$Y = 0.20 - W$$

$$W = \frac{1.45274 - 1.4520}{0.0749} = 0.0099$$

Therefore,

$$Y = 0.20 - 0.0099 = 0.1901 \text{ inch}$$

* * *

For five years, transmission lines in Southern California have proved successful for transmitting electric current at 150,000 volts. The total power developments from hydraulic sources in California now equal 325,000 kilowatts. There are four large projects that could be developed to give 1,500,000 kilowatts additional within a few years. It has been suggested that the power from these projects could be distributed over a large area by 220,000-volt transmission lines. By using 60 cycles, all the power stations of the state could be linked together.

TENDENCIES IN ELECTRICAL POWER DEVELOPMENTS

In a summary of the past year's activities furnished by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., the following main facts are mentioned as indicating the trend of the present practice in the application and use of electricity in various forms: (1) A growing tendency toward the centralization of power generation for large areas, evidenced by the ever-growing loads on the stations of public utility companies, with a consequent demand for larger power units. (2) A generally acknowledged preeminence of electric drive in the industrial field, most modern factories and mills now using this form of power in preference to steam. (3) An increasing use of electric power for electric welding and electric furnaces. (4) A revolution in agricultural life, not only by making it more profitable, but by providing it with many of the comforts and conveniences heretofore found only in the city. (5) The increasing application of electric appliances to domestic purposes.

The use of the electric arc as a practical and economical method of fusion of metal in manufacturing processes has extended so rapidly during the past two years that new types of equipment have been developed to meet the particular requirements of the service. Although the arc welding process has been used for years on special applications, for repair work, and in general foundry work on the repairing of defective castings, its economy in replacing riveting and other means of fastening metals, in general manufacturing processes, has only lately been realized. The tendency in arc welding equipment is toward units of a capacity large enough for one operator only. These units may be stationed about the shop or yard at points where they are to be used or are readily made portable so that they can be moved to the point at which work is to be performed.

* * *

NEW DEVELOPMENT IN TRANSMITTING SPEECH

In an article in the *Proceedings of the Physical Society*, A. O. Rankine calls attention to some new and very remarkable developments in scientific research. Selenium changes in electrical resistance according to the light flux incident upon it. For several decades attempts have been made to transmit speech by using this fact. A beam of light is made to vary in intensity by the changes of pressure in a sound wave. This beam is received upon a selenium cell in circuit with a telephone receiver and a source of current. As long as the intensity of the light is constant so long is the current through the receiver constant. When, however, the intensity of the light changes, the resistance of the selenium changes and in consequence the current varies and the diaphragm of the receiver is made to move and to emit a sound wave.

There are two methods of making a beam of light fluctuate in intensity in accordance with the sounds of the voice. One is by controlling the light emitted by a source such as an arc lamp, by microphone action or otherwise. It is said that this method has been used with success in the German navy over a distance of seven miles. The other method is to keep the source of light constant but to vary the intensity of the beam after it has started. The first method can, of course, be used only with artificial sources, while the second is applicable to sunlight. By the use of a seven-inch lens and a "pointolite" lamp, the range is half a mile. More intense sources, of course, extend the range. Using the sunlight, the faintest whisper was heard at a distance of one and a half miles.

* * *

A bill has been introduced in the British Parliament to prevent "dumping." This bill proposes to prohibit the importation into Great Britain of goods at prices below the selling prices in the country of manufacture. This bill also provides for the prohibition of the importation of specified classes of goods under the designation of key industries.

Combating Excessive Manufacturing Costs

By S. P. KEATOR

IN the profitable operation of a factory, several cardinal points must be considered. Many of these points are not generally given the thorough study merited by their importance.

The accounting department of practically every company carefully accounts for each dollar spent. The cash-paid-out records have every expenditure annotated in its proper place, and all accounts are checked as carefully as are bank accounts. After the money has been converted into raw stock or work in process, however, (although the full purchase value is still there), it rarely happens that careful consideration is taken to insure the accounting of every dollar's value. Work in process increases in value in proportion to the number of operations or amount of work performed upon the part or machine in question. This is a further argument for guarding against loss of stock through either workmen's carelessness or defective material. If a lot of 1000 castings is started through a shop, and on account of breakage and spoiled work only 800 perfect pieces are completed, the cost of material must certainly be the original cost of 1000 pieces, pro-rated among the 800 perfect ones. The greater the spoilage, the greater is the material cost per unit. Even though the individual may not believe in the logic of thus apportioning spoilage costs against direct production costs, this additional cost must be carried as an overhead expense and must eventually be applied to the production costs.

Conservation of Raw Material

Care in the conservation of raw material should be exercised from the time it is received at the plant. A rigid inspection of all incoming materials before signing carriers' receipts should be insisted upon. Considerable damage is often caused by the rough handling of shipments, and sometimes the nature of the damage is such that it is not detected during the inspection made by the shipping clerk. For instance, a certain plant which purchased castings weighing approximately 100 pounds, found that due to rough handling or poor casting methods a large percentage of the castings received contained fine cracks which were hardly perceptible to the naked eye. These castings were often snagged or cleaned and partially machined before the defects were detected, and a considerable amount of labor was thus uselessly expended upon them. A claim was made against the foundry supplying the castings for the losses sustained, but the foundry (with considerable justification) claimed that the castings were cracked in transit and on these grounds refused to make restitution. A plan for rigid inspection was then instituted whereby the castings were thoroughly gone over before the freight receipt was signed. The castings rejected effected a tremendous saving, and the spoilage in this type of castings dropped from twelve castings a day to an average of less than two castings per day. The castings were valued at $6 each; the saving through inspection, therefore, amounting to about $60 a day.

Ordering and Inspecting Raw Materials

Inspection at the receiving room of the plant is the first step and one of the most important safeguards against spoilage and waste. The amount of money saved through the rejection of defective raw materials will more than pay the maintenance cost of an inspection force; in fact, an inspection force properly directed will pay large dividends in time, money and trouble saved. Careful planning of production schedules and care exercised in routing work while in process, coordinated with the prompt follow-up of purchased material by purchasing departments, are also important factors of economical operation.

Thorough study of part lists is required of the routing engineer, so that no part may be neglected. A knowledge of the usual percentage of spoilage is absolutely essential. For example, consider two bronze bushings, one 6 inches long and one 1/8 inch long. The waste or crop ends from each bar of raw stock required for the longer bushings will be far greater than the waste from the stock required for the short bushings. In the case of the longer bushings, the waste ends of stock may be from 2 to 3 inches long, or even more, while the length of the crop ends from the short bushing stock will be negligible. All this must be taken into consideration when planning for stock, because in lists calling for several thousand units, the waste from crop ends plus the machine spoilage is considerable, and full allowance must be made to cover it when ordering stock.

Importance of Follow-up

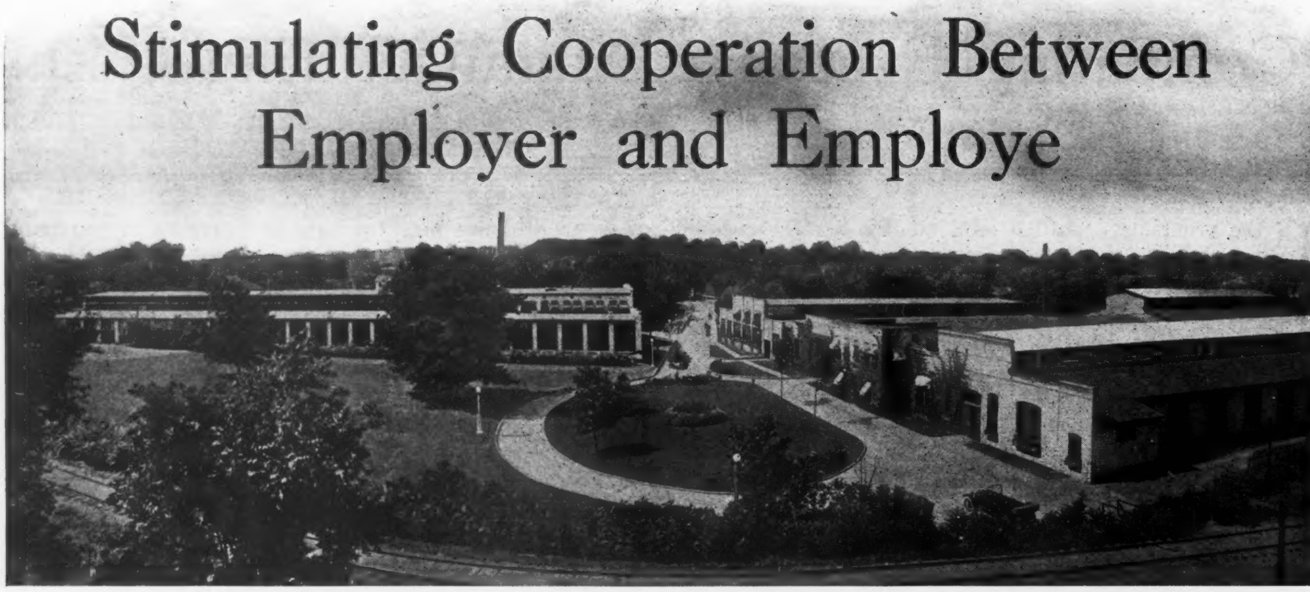
Without an accurate system of following up orders, the purchasing department has no reliable data which can be used as a guide in purchasing and planning for production. The writer recalls an instance where, through lack of coordination between production and purchasing departments, several hundred dollars worth of expensive bronze was converted into chips simply because in order to sustain production and supply a needed part, it was necessary to use 1 1/2-inch diameter rods to make an article 1/2 inch in diameter. In this instance, not only was the bronze wasted, but also the labor required to reduce the bronze to the specified diameter. A loss of over $1500 was experienced in this case, which could have been prevented if the purchasing department had properly followed up the purchase order. Production had to be maintained, of course, but the loss could have been avoided by proper teamwork between production and purchasing departments.

Much can be accomplished in preventing waste and production spoilage by encouraging the workmen to guard against the breakages and spoilage, and by rewarding them when any considerable saving is effected through their efforts. Analysis of the spoilage of parts and a compilation of these data will constitute an easily understood report. Such reports should be made available for use by the production engineer and superintendents, and should also be used to bring the facts before the foremen and workmen.

Value of Cost Reports

Another aid to economical operation is an accurate cost report. Many plants maintain elaborate cost systems and tabulated reports, but many times these reports do not reach the men who would be influenced by them to cut down production costs. The writer believes that the superintendent and production men would be greatly aided in their work if kept constantly advised as to production costs. Great care should be taken to see that cost reports sent to shop executives be in as simple a form as possible, as most factory executives have not the time to study complicated reports. Material and labor costs are of most importance to the operating executive. Therefore it is a good plan to limit reports to these two direct cost elements. The shop superintendent and the production man are the executives directly responsible for gain or loss and should be entitled to a general knowledge of the results of their efforts.

Stimulating Cooperation Between Employer and Employe



Based on an Interview with Eugene B. Clark, President of the Clark Equipment Co.

AN authority on industrial management recently expressed the opinion that a factory worker earns his wages and pays his proportion of overhead expenses by the purely mechanical performance of an allotted task, while the return on the capital invested is measured by the degree of enthusiasm with which the work is performed. Another business man of national prominence stated that any principle of business administration which is to prove permanently beneficial to both employer and employe must tend to advance the interests of both. Granting the truth of these statements, it will be of interest to consider how the interests of both the management and the workers are affected by the carefully thought out plan of the Clark Equipment Co., in Buchanan, Mich., gradually developed during the past ten or twelve years with a view to creating industrial relations which would keep the employes satisfied and thus tend to heighten the enthusiasm with which they perform their daily work.

Of late, we have heard of many applications of industrial democracy; and it may be truly stated that the methods adopted by this company represent a true application of democratic principles. Direct primary elections are held in each department of the plant to nominate three candidates for election to membership on the Employes' Council; and subsequent elections determine the selection of one of these three men to serve for a period of one year. The men employed in each department of the plant are personally acquainted with their councillors and express freely to them their opinions concerning all matters pertaining to working conditions. Hence the councillor forms a direct line of communication between the men and the management. Council meetings are held once a week, and it is the duty of the councillor to present for consideration any matters affecting the men employed in the department which he represents; and all decisions reached at each council meeting are posted on bulletin boards provided in each department of the plant. The work of the Employes' Council and the suggestion of matters deserving its consideration form a topic of "shop politics" which makes a far more interesting noon-hour discussion than federal or municipal politics, because it has a more direct bearing upon the conditions surrounding each man's means of earning a livelihood.

Unless a man takes an interest in his work, he will seldom be satisfied; and conversely, any plan which tends to stimulate a man's interest in his work is also likely to assist in keeping him satisfied with working conditions. The man who is satisfied and does his work enthusiastically is not only going to be happier and healthier than the fellow who has a chronic grouch, but, other things being equal, he is the type of man who is most likely to acquire a fund of mechanical knowledge and develop a capacity for managing men that will warrant his advancement to a more responsible and better paid job.

Basic Principles in Creating Cooperative Industrial Relations

Most work of permanent value has been done slowly, and this is true of the Clark Equipment Co.'s efforts to steadily improve the working conditions of its employes and to provide facilities for their entertainment and physical development. But at the stage which has at present been reached in carrying on this work there are two fundamental principles of management which are largely responsible for the successful results that have been obtained. These principles are as follows:

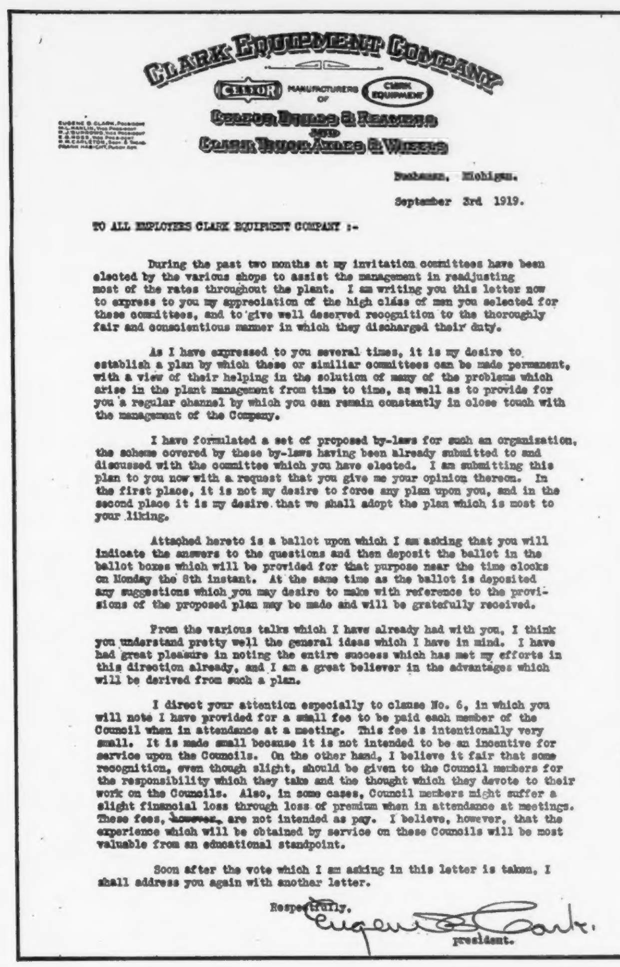
Conscientious efforts made by the executives of manufacturing plants to evolve methods of management that will be mutually satisfactory to the employer and his employes, may prove unsuccessful through failure of men in charge of an industrial enterprise to understand the workmen's point of view. Factory officials who worked in the shops before being placed in charge of more responsible work, will find this experience of great value in enabling them to understand the workmen's attitude toward the management of the plant in which they are employed. Eugene B. Clark was graduated from the Engineering College of Cornell University in 1894 and entered the employ of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., where he was engaged for two years on engineering work both inside and outside the plant. While gaining this experience, Mr. Clark worked with the men in the shops. In 1896 he went to the Illinois Steel Co., Chicago, Ill., where 10,000 to 12,000 men were employed, and his duties there gave constant opportunities of gaining a knowledge of the workmen's viewpoint. After eleven years spent with the Illinois Steel Co., Mr. Clark had risen to the position of assistant manager. He resigned in order to purchase the Celfor Tool Co., and later organized the Buchanan Electric Steel Co. On January 1, 1917, these two companies were consolidated under the present name of the Clark Equipment Co.

To adhere to a uniform policy in dealing with employes, so as to gain and retain their confidence in the intention of the company to be fair; and to foster the idea that employes are working *with* the company as partners rather than *for* the company as employes.

To provide well lighted and efficiently ventilated workshops that are equipped with drinking fountains, locker rooms, adequate toilet facilities and all other necessary conveniences required to bring working conditions up to the highest level consistent with the nature of the work to be done.

Confidence of Employes Easy to Maintain but Difficult to Regain

Probably there is no one factor which has a more adverse effect upon the industrial relations than to have a condition arise which causes employes to lose faith in their employer. So long as the employer deals fairly with his men and they have confidence in his intention to continue doing so, little trouble is likely to be experienced; but if this confidence is once lost, it may take a long time to restore it. It has been a uniform policy of the Clark Equipment Co. to take pains to have its employes feel that they will always be fairly treated. If any group of men believes that there is reason to be dissatisfied with certain working conditions, the management does not take the word of foremen or other subordinate executives as to the feeling of the employes working in their departments. The employes' representation plan makes it easy for the men to appeal to the higher officials, and any complaint will receive careful consideration and be dealt with strictly upon its individual merits. By following such a plan the men have come to know that the company is not only willing to pay them a fair rate of wages, but that it is anxious to have all questions concerning working conditions adjusted upon a basis which is satisfactory to all concerned.



CLARK EQUIPMENT COMPANY

Buchanan, Michigan.

September 3rd 1919.

TO ALL EMPLOYEES CLARK EQUIPMENT COMPANY :-

During the past two months at my invitation committees have been elected by the various shops to assist the management in readjusting most of the rates throughout the plant. I am writing you this letter now to express to you my appreciation of the high class of men you selected for these committees, and to give well deserved recognition to the thoroughly fair and conscientious manner in which they discharged their duty.

As I have expressed to you several times, it is my desire to establish a plan by which these or similiar committees can be made permanent, with a view of their helping in the solution of many of the problems which arise in the plant management from time to time, as well as to provide for you a regular channel by which you can remain constantly in close touch with the management of the Company.

I have formulated a set of proposed by-laws for such an organization, the scheme covered by these by-laws having been already submitted to and discussed with the committee which you have elected. I am submitting this plan to you now with a request that you give me your opinion thereon. In the first place, it is not my desire to force any plan upon you, and in the second place it is my desire that we shall adopt the plan which is most to your liking.

Attached hereto is a ballot upon which I am asking that you will indicate the answers to the questions and then deposit the ballot in the ballot boxes which will be provided for that purpose near the time clocks on Monday the 8th instant. At the same time as the ballot is deposited any suggestions which you may desire to make with reference to the provisions of the proposed plan may be made and will be gratefully received.

From the various talks which I have already had with you, I think you understand pretty well the general ideas which I have in mind. I have had great pleasure in noting the entire success which has met my efforts in this direction already, and I am a great believer in the advantages which will be derived from such a plan.

I direct your attention especially to clause No. 6, in which you will note I have provided for a small fee to be paid each member of the Council when in attendance at a meeting. This fee is intentionally very small. It is made small because it is not intended to be an incentive for service upon the Councils. On the other hand, I believe it fair that some recognition, even though slight, should be given to the Council members for the responsibility which they take and the thought which they devote to their work on the Councils. Also, in some cases, Council members might suffer a slight financial loss through loss of premium when in attendance at meetings. These fees, ~~however,~~ are not intended as pay. I believe, however, that the experience which will be obtained by service on these Councils will be most valuable from an educational standpoint.

Soon after the vote which I am asking in this letter is taken, I shall address you again with another letter.

Respectfully,

Eugene B. Clark.

president.

Fig. 1. President's Letter to Employes announcing Vote on Representation Plan

Employes' Representation Plan

A great deal of the trouble that exists between the management and workmen in many manufacturing plants arises from taking the word of foremen and superintendents in regard to the sentiment of employes, instead of having the management make a conscientious effort to obtain first-hand information. The employes' representation plan of the Clark Equipment Co. provides a means for obtaining this information. Under this plan regular meetings by two councils composed entirely of employes are held, at which measures for improving working conditions, manufacturing efficiency, etc., are formulated and brought to the attention of the management of the company. In line with the company's policy of giving employes the fullest possible voice in determining matters affecting working conditions, a meeting was first held at which the features of this employes' representation plan were explained. Then a letter from the president of the company, reproduced in Fig. 1, was mailed to the home of every employe, giving a brief outline of the proposed plan and calling attention to a vote that was to be taken in the shop to gain an idea of the consensus of opinion among the men regarding the desirability of adopting such a measure. This vote expressed a strong sentiment on the part of employes to have the new system adopted.

In addition to the committee's preliminary work in readjusting rates throughout the plant, as mentioned in the president's letter, the permanent maintenance of the committee or council affords a channel through which any man or group of men in the plant may readily express to the management an opinion concerning any situation affecting his working conditions. Under this plan there have been established what are known as an Employes' Council and a Joint Council. It is proposed to divide the plant up into districts composed of each department of the plant employing a large number of workers, or several departments in those cases where the number employed in each department is small. The Employes' Council is composed of two representatives elected by the men of each district. Elections for this purpose are held in January and July of each year, and every employe who has been in the service of the company for three months, provided he is not a foreman, is entitled to vote.

Voting is accomplished by secret ballot, and the election is divided into two parts with at least three days intervening. The first part of the election is for the purpose of nomination, and the three candidates having the greatest number of votes in each department or district are declared nominated; the names of these three candidates are then posted in the plant until the second part of the election, the result of which elects one of these three employes who were nominated by the direct primary election. An employe must have been in the service of the company for six months immediately preceding his election, in order to be eligible to serve on the Employes' Council. Members of this council serve for a period of one year, and one member is elected each six months. For instance, each district having two representatives will elect one representative in January and one in July, each of whom will serve for one year. Foremen are not eligible to serve as members of this council.

Personnel of the Joint Council

Of the ten members of the Joint Council five are elected by members of the Employes' Council from among their own number, and five are appointed by the president of the company from the general staff of the firm, preference being given to employes in departments which are not generally classed as producing departments, the intention being to secure general representation of the employes by including members of the sales, purchasing, engineering, research, and advertising departments. Meetings of the councils are held each Thursday afternoon, at 2 P. M., in the following order: First Thursday each month, meeting of Employes' Council;

Form 505—6-6-19-5m

ABSENT REPORT

NAME................................ CLOCK NO...... DATE..........

A—Absent with permission of foreman.
B—Absent, no reason known.
C—Reported sick or disabled.
D—Reported sickness in the family.
E—Verified report of disability.
F—Injury received at plant.
G—Laid off. Slack work.
H—Laid off. Discipline.
V—Vacation.

SIGNED ....

NOTE: Please place a check or cross in front of the item in the above which covers reason of absentee. CHECK means all day. CROSS means half day.

Fig. 2. Form used by Foreman in reporting Absence of Employes and the Reason. These Data are recorded in the Office of the Director of Industrial Relations

second Thursday each month, meeting of Employes' Council; third Thursday each month, meeting of Joint Council; and fourth Thursday each month, meeting of both councils.

Meetings of the Employes' Council and of the Joint Council are presided over by chairmen elected by members of the respective councils, and the joint meeting of both councils is presided over by the president of the company, or, in his absence, by one of the vice-president. None but members of the Employes' Council or of the Joint Council are permitted to attend the meetings, except that either council is privileged to invite any executive or employe of the company to appear at its meetings and give any information desired by the council. Also, the president may invite employes of the company who are not members, to attend the combined meeting of both councils. Each council conducts its meetings in parliamentary form and keeps a record book in which the minutes are recorded. These record books are available for inspection by any employe of the company, and all employes are kept informed concerning the work done by the councils through reports on bulletin boards in the plant. The business considered by these councils consists of all matters pertaining to working conditions, including such features as safety, amusement, recreation, and measures designed to improve the efficiency and economy of the manufacturing operations.

No suggestion having a bearing upon conditions of employment in the plant or the relations existing between any employe and the company is ever barred from discussion. Any action adopted by the Employes' Council is put in the form of a "bill" which is then introduced for the consideration of the Joint Council. If favorable action is taken by the Joint Council, the bill is then passed to the president of the company, and if he signs the bill it will automatically become a part of the law of the plant. This employes' representation plan does not abridge or interfere with the established rights of any officer or employe of the company. Its purpose is to bring about closer relations between the employes and officers, and to insure uniform justice to every employe, as well as to improve the shop methods with a view to securing the maximum efficiency in production; and the application of the plan has proved it to be successful in accomplishing these results.

How Employes Become Stockholders in the Company

It has been stated that an effort is made to have all the company's employes feel that they are working with the management as partners, rather than for the management as employes. Numerous means have been employed to emphasize this, but the most obvious of these is a plan inaugurated in 1916 by which all employes are encouraged to become stockholders in the company. Each employe is permitted to buy stock, the amount of his annual subscriptions being up to 10 per cent of his yearly earnings. These subscriptions are made for what are known as "lots" of stock costing $150, each of which consists of one share of preferred stock of $100 par value, which pays a dividend of 7 per cent per annum, one share of common stock of $100 par value, and one employes' participating profit-sharing certificate of no par value, on which a dividend is paid at the minimum rate of $6 per annum, or at such higher rate as may be decided upon by the board of directors. In a period of exceptional prosperity, such as the years just past, this special distribution to holders of participating profit-sharing certificates has been very substantially in excess of the stipulated rate of $6.

Payments for these lots of stock purchased by employes are made in cash at the office of the company's treasurer, any amount from $1 up being acceptable. The usual partial payment plan for the purchase of securities is followed, and all dividends and other distributions accruing from the ownership of stock are credited to the amount of the purchaser until payment has been completed. The stock is then made out in the name of the purchaser and delivered to him. If an employe desires to cancel his subscription for stock after payments have been started, or if he leaves the company either voluntarily or for cause, the amount of money which he has paid on his partially completed subscription will be returned with interest at 5 per cent. No interest charge is deducted for that portion of the total obligation which remains unpaid.

If employes who have completed paying for one or more lots of stock leave the employ of the company they may or may not retain their stock, as desired, but those employes who elect to continue the ownership of stock will forfeit the income from their participating profit-sharing certificate, as this is a special distribution made to stockholders actually on the payroll at the time the distribution is made. Also, employes who remain in the company's service but dispose of their stock to an outside purchaser automatically cause their participating profit-sharing certificate to become void, as this part of the investment is not transferrable. In the event of the permanent disability or death of an employe who has completed payment for one or more lots of stock, the company agrees to redeem his participating profit-sharing certificates at the rate of $50 each; and in the case of employes who suffer a similar misfortune during the time that they are paying for one or more lots of stock, the participating profit-sharing certificates are redeemed at the rate of $15 each.

Results Obtained by Having Employes Become Stockholders

Two reasons led to the inauguration of this plan by which employes have been enabled to become stockholders in the

A—Absent with permission of foreman.
B—Absent no reason known.
C—Reported sick or disabled.
D—Reported sickness in family.
E—Verified report of disability.
F Injury received at plant.
G—Laid off. Slack work.
H—Laid off. Discipline.
V—Vacation.

ATTENDANCE RECORD

Form 495-3-10-19-1500

NAME CLOCK NO.

WEEK ENDING	MON.	TUES.	WED.	THUR.	FRI.	SAT.	TOTAL	V	WEEK ENDING	MON.	TUES	WED.	THUR.	FRI.	SAT.	TOTAL	V

Fig. 3. Form used by Director of Industrial Relations to maintain Card File Record of the Employes' Regularity of Attendance which determines their Eligibility for Vacations

company—namely, to promote thrift among the men and to foster the idea of partnership between the management and the men in conducting an enterprise in which both have a common interest. The first of these reasons requires no comment, but it will be of interest to note several of the beneficial results which have been obtained by the spirit of partnership that has been created by stock ownership. When a new man is being "broken in" in many shops, it is not at all uncommon to see the experienced employes ridicule his somewhat clumsy efforts to master the details of a new kind of work; and while he is learning, the inexperienced employe is likely not only to do very little useful work but also to completely spoil many partially finished parts. Where the other employes are merely working "for" the management, the loss resulting from this lack of knowledge on the part of a new man does not seriously disturb them; but in a plant where the employes are also stockholders, the situation immediately assumes a very different aspect. Each man realizes that out of every dollar wasted through the spoilage of material, a certain part comes out of his own pocket, and he will do everything possible to stop such leaks. Thus at the Clark plant, where a new employe is having any trouble, he is almost certain to have one of the experienced stockholding employes in the same department give him a few words of advice or suggestions about handling the work, which soon enable him to master the difficulties encountered.

Safeguarding the Common Interests of the Firm

The same tendency is shown by employes who are stockholders to see that none of the tools and supplies used are stolen or mislaid. The following is an interesting case in point. Recently a contractor was employed to make certain changes in the plant and his men were at work at the time that the shop was running. When these men had finished their work and were packing up tools and other supplies belonging to the contractor, a stockholding employe of the Clark Equipment Co. saw one of them pick up a portable electric drill and put it into his tool bag. The Clark employe did not think anything of this matter at the time, but later it occurred to him that the electric drill belonged to his company instead of the contractor whose men were working in the plant. This incident was reported to the foreman of the department and an investigation resulted in the recovery of a tool worth possibly $50. Many other similar incidents could be cited to show the care with which those men who are stockholders in the company guard the common interest which they have in all matters pertaining to its welfare.

QUESTIONNAIRE

Name __________
Age __________
How long have you lived in Buchanan? __________
Present Address __________
Do you own your own home? __________
If not, how much rent are you now paying? __________
How many rooms? __________
Heat? __________
Gas? __________
Electric Lights? __________
Bath? __________
What is your trade or work? __________
Wages? __________
Any other source of income? __________
Where employed? __________
How long? __________
Last previous place employed? __________
How long? __________
How many members in your family? __________
How many children under 15 years old? __________
Do you keep boarders or lodgers? __________
How many wage earners in your family? __________
Would you be interested in buying a new house or lot on easy payments? __________
Do you own a Liberty Bond? __________
Have you any stock in this Company? __________
Have you any debts or other obligations that would make it difficult to make payments? __________
How large a first cash payment can you make? __________

Fig. 4. Form of Questionnaire used in determining the Financial Reliability of Prospective Purchasers of Homes

Stockholders' Meetings

As stockholders of the company, it is felt that all employes who have made an investment in stock should be kept informed as to the condition of the firm's business. With that idea in mind, at least four meetings are held each year, at which all stockholding employes are urged to be present. These meetings are presided over by the president of the company, or by one of the other higher officials. Statistics are given as to the condition of the firm's business and information regarding new orders which have been taken since the last meeting was held. At these meetings, the presiding official is prepared to answer all reasonable questions bearing upon the condition of the company's business. In this way all stockholding employes are able to acquire a knowledge of the affairs and business prospects of their company and thus assume the position of true partners in the enterprise.

Hygienic Work-shops and Well Kept Grounds

From the title illustration, which shows a partial view of the factory and its grounds, it will be apparent that the buildings have a liberal amount of window space. All buildings are of the most modern type of construction, with steel-framed windows running practically the entire distance from the ground to the eaves, while windows in the monitor roofs furnish additional light. There are modern ventilating systems which assure the circulation of fresh air, and drinking fountains are well distributed throughout the plant.

As he comes to work in the morning, the employe is greeted by the sight of beautifully kept lawns decorated with flower beds and shrubs. To work efficiently that man must be in good health. In spending time and money upon the maintenance of attractive grounds surrounding its plant, the company's purpose has gone beyond the attainment of a decorative effect. It is thought that the natural reaction on the workmen who enter the shops, after crossing grounds decorated with lawns, shrubbery and flowers, will be to take to their work a desire to make it approach the perfection with which nature's handicraft is performed. In order that the ground surrounding the factory may be maintained in excellent condition, an experienced gardener is kept constantly on the company's payroll and a well equipped greenhouse is provided for his use in obtaining the great quantity of bulbs and plants that are required to produce the wonderful horticultural effects obtained.

Vacations for Men Employed in the Shops

Most of the workers in manufacturing plants are paid by the hour, that is to say, a deduction is made from their pay for any time that they are absent from the plant during working hours. Naturally this general system is followed at the Clark plant, but employes who fulfill certain requirements in the performance of their year's work are given a vacation with pay. The general plan is to give a vacation of one week to each man who has been on the payroll for one year or more, and three days to each man who has been in the company's service for at least six months; but in order to be eligible for this vacation there are certain other requirements which a man must fulfill. For each day of absence without an approved cause the employe loses 1 per cent of his vacation. Thus the vacation is made an incentive for regular attendance. Fig. 2 shows the absence report form which is made out by the foreman of the department and sent to the office of the supervisor of industrial relations, indicating the cause; absences coming under the heading B or H result in the penalty of a deduction from the man's

vacation. A permanent record of these reports is kept on cards of the form shown in Fig. 3, and at the end of the year this card record shows the amount of deduction, if any, which is to be made from the vacation of each man in the plant. The employes are given a Saturday afternoon holiday with pay each week. In order to obtain this benefit, however, they must not come late or leave the plant before the authorized quitting time. Any man failing to fulfill this requirement is not paid for Saturday afternoon.

Allowance Made for Transportation

Buchanan is a town of approximately 3000 inhabitants, and a large majority of the working people in this community are employed by the Clark Equipment Co. Owing to the rapid growth of business and the need of more workers, one of the problems that required attention was that of providing transportation for those who come from other towns, or houses to accommodate men who desire to bring their families to live in Buchanan. Taking these two questions in the order in which they have been named, it may be mentioned that there are 180 men who come from towns surrounding the plant over a radius of sixteen miles. Men who ride ten miles or less to reach the plant are given an allowance for transportation of 30 cents for the round trip, and such an allowance is also made in the case of those men who have their own motor cars. Men who have to ride further than ten miles get an allowance of 40 cents for the round trip. This plan tends to create an adequate supply of labor, because those who would be deterred from seeking employment with the company, owing to difficulty of reaching the factory, are induced to come.

How the Housing Problem has been Solved

An ambitious housing plan has been worked out for the benefit of those employes who wish to live in Buchanan but are unable to secure the type of living accommodations which they desire. The company bought a tract of land on high ground overlooking the plant and sub-divided it into building lots, this section of the town having been given the name of "Liberty Heights." To date, forty-three houses have been built for employes, the price of which ranged from $2500 to $4500. In every case, the purchase price of the house represents the actual cost of construction; the price of the lot is the cost of the ground to the company on an acreage basis, plus a profit of 100 per cent. At the end of five years, or sooner if all payments have been made on the transaction, this 100 per cent profit on the cost of the land is returned to the purchaser with interest at 5 per cent, the idea of returning this margin of profit being to create an additional incentive for those who purchase houses to complete their payments and become home owners. It may be mentioned, however, that this return of the profit on the land is only made in the case of buyers of homes who are still employes of the company.

The houses are sold to the workers on most liberal terms, the amount of the initial payment which is required and the rate at which the balance of the obligation must be paid off being far lower than is the case in dealing with real estate companies. Hence, the employes who purchase houses on these liberal terms of payment are greatly benefited, but the company is obtaining a partial return on its outlay of money through the fact that a man who buys a home is far less likely to leave the employ of the company and move to another town.

Advantages of Organizing a Separate Land Company

It was considered best to handle these real estate transactions by avoiding any idea of paternalism on the part of the company; for that reason the Buchanan Land Co. was formed to handle all of this business. By having dealings with a separate company, it is also made easier for an employe to quit his job and still continue making payments on the house. The land company is presided over by the purchasing agent of the Clark Equipment Co., who acts in the capacity of general manager. To facilitate his work in dealing with those employes who desire to purchase homes, a standard questionnaire was prepared, and the first step taken by a man who is interested in becoming a householder is to apply for one of these blanks, which he fills out and returns to the manager of the Buchanan Land Co. The questionnaire is shown in Fig. 4. By looking over the man's answers to these questions a reasonably accurate idea can be secured as to his financial reliability and as to the probability of his fulfilling his obligations. It is important to note that the practice is to build exactly the type of house which is desired, rather than to sell a house which has already been built. A large variety of architects' plans are available for selection, or the purchaser may provide his own plans. The age and earning capacity of the prospective purchaser and other factors of a like nature are carefully considered, and he is not allowed to obligate himself for the purchase of a piece of property where the price is so high that there is little probability of his being able to complete making the required payments within a reasonable length of time.

Fig. 5. Interior of Greenhouse where Plants and Bulbs are propagated to decorate the Grounds surrounding the Plant

Clark Hospital Association

No hospital facilities were available in Buchanan until a decision was reached by the Clark Equipment Co. to provide a fully equipped building with adequate facilities to render surgical and medical service to the company's employes and their families. In handling this project, as in the case of the land company, it was desired to avoid any evidence of paternalism, and for that reason the hospital was equipped and turned over to the employes of the company to manage. The plan finally adopted consisted of the formation of an organization, known as the Clark Hospital Association, the charter of which allows any resident of the town to become a member, upon payment of an annual fee of $2, regardless of whether or not he is an employe of the company. This institution has been in operation for nearly a year and has already rendered valuable service. A board of directors which is responsible for the management of the hospital consists of men elected by the members of the Hospital Association.

Aside from humanitarian aspects, it is felt that this hospital, providing means of caring for employes of the company and members of their families, is an excellent business proposition. It is probably safe to say that 75 per cent of all surgical operations are performed on women patients. In Buchanan, as in many similarly situated manufacturing towns, a man whose wife became ill formerly had to send her away if surgical treatment was required. This not only cost him a lot of money, but also necessitated paying visits that took him away from his work; and delays in reporting progress made by the patient on those days that the man was actually at his job caused him to be less efficient than usual. Where the patient is at the Clark Hospital, a man employed in the plant is able to pay as many visits as may be desirable, and he is kept constantly informed as to the progress made by the patient, so that his efficiency as a workman is reduced as little as possible under the circumstances. For this reason it is believed that money required to put the hospital in operation is a profitable investment for the company, in addition to being a great help to the men.

The Theater and Allied Activities

In order for a man to do his work efficiently and to live a happy normal existence, both his mind and body must have recreation. Recognizing the truth of this fact, a theater was built right in among the factory buildings, lawns, and flower beds, and here various forms of entertainment are given to afford enjoyable pastimes for the winter evenings. Accommodation is provided for seating 1000 people, and the building is equipped with the regulation stage and footlights, dressing rooms, property rooms, etc. A theatrical company known as the Clark Players, recruited from those employed in the shops and offices, has been trained under the direction of a vice-president of the company who formerly had some theatrical experience. Four plays are staged every season, each play being presented three times.

In addition to giving performances at the plant, the Clark Players have made a practice of going to nearby towns, upon request, where they have given their plays with very successful results, the proceeds of such outside performances being donated to the Theater Association. Last year this association donated $800 to the Red Cross, $800 to a specially equipped hospital to care for influenza patients, and $100 to the Clark Hospital Association, after paying all expenses such as royalties on plays, the cost of stage settings, etc. The theater was opened on March 26, 1918, with a minstrel show. During 1918 the attendance at the theater was 10,944 with an average attendance of 421 for each entertainment that was given. The price of admission was first fixed at 50 cents, but later this was reduced to 25 cents with a 3-cent war tax, in order to bring the cost of the evening's entertainment low enough so that all members of a workman's family could come together.

In addition to the theatrical performances, this theater is used for moving picture entertainments, lyceum lecture courses, basket ball games, dances, smokers, etc. Not only is the provision of such a meeting place almost an essential in a moderate sized town, where there is only one other theater in which moving pictures are the sole form of entertainment, but a little thought will make it apparent that the holding of general meetings of this kind among employes is of great value in fostering a spirit of fellowship which enables them to cooperate far more efficiently during the hours they spend at work in the plant.

At the front of the auditorium in the theater, the seats are removable, leaving a clear floor space which is adapted for use in playing basket ball and for dancing. These two forms of entertainment are mentioned together because a practice is made of giving a dance after the basket ball game has been finished. Music for these dances is furnished by an orchestra, the members of which are all Clark employes. There is also a Clark band organized along similar lines. Basket ball teams have been organized among both the men and women employes, and matches are arranged with teams from nearby communities.

Cooperative Store

The high cost of living has led numerous industrial establishments to organize stores in which their employes are able to buy groceries and certain other necessities of life at prices based upon actual cost. Most of these stores have been placed right in the factory, and although they have given excellent service, there have been justifiable criticisms of the results obtained, important among which is the fact that the men of the family have to do the marketing at the plant, which is likely to create a certain amount of interference with their work. To overcome these difficulties, the cooperative store which employes of the Clark Equipment Co. have organized is located in a building in the shopping district of the town. As in the case of managing the hospital, there is an association known as the Cooperative Store for Clark Employes, to which any employe of the company is eligible for membership upon the payment of a fee of $15. The company furnishes the building in which the store is maintained and pays such expenses as light, heat and delivery service; but all other expenses of management come out of the small profits made on the sale of goods.

In order that members of the association may have the benefit of the lowest possible prices, this store operates on the principle of cash dealing; and an additional saving is effected through only making one delivery a week and that limited to purchases amounting to $5 or over. In certain cases it is necessary to grant credit, but it is also desired to

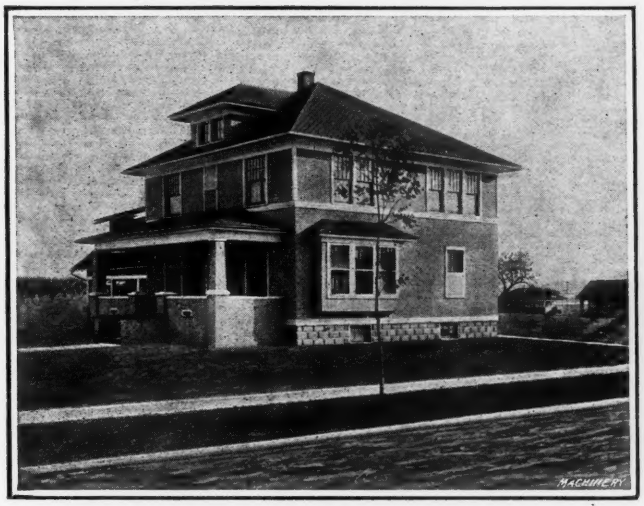


Fig. 6. One of the Larger Sized Homes built for a Clark Employe on "Liberty Heights"

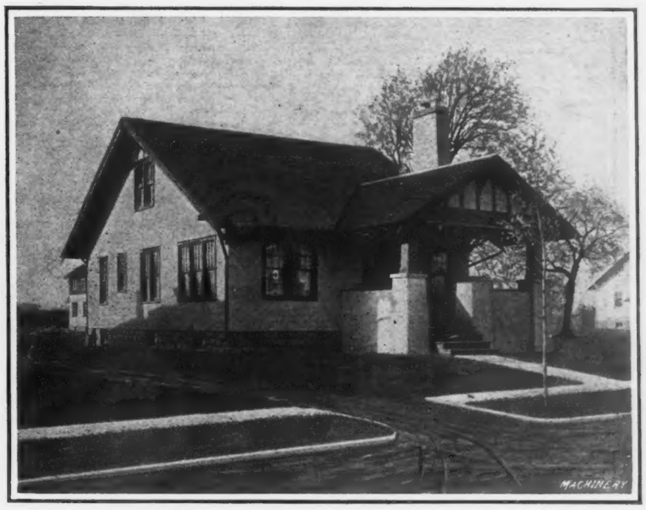


Fig. 7. A Comfortable Bungalow built to suit the Requirements of a Small Sized Family

protect members of the association against the possibility of bad faith or misfortune on the part of those who apply for such accommodation. With this idea in mind coupon books are issued, after the merits of each individual case has been passed upon by the cooperative store committee, and a deduction corresponding to the amount of this coupon book is made from the next pay received from the company in order to reimburse the cooperative store for the advances it has made. In no case is a longer credit than two weeks granted. Membership in the association allows all members of the immediate family to make purchases at the store, and by having the store in the town the women of the family are able to do the marketing.

Provisions of the Benefit Association

Any employe of the company working on a wage basis is eligible for membership in a mutual benefit association which provides relief in the case of sickness, death, or accidents occurring outside of the plant. No provision is made for recompensing employes for time which they may lose in the event of accidents occurring in the plant, because this risk is taken care of by the employer's liability. The premium paid by members of this association is 6 cents a month for a claim of $1 a day for any period up to a maximum of twelve weeks. Insurance may be effected on this basis for any amount up to a maximum claim of $21 per week; and in any case, the payment made in the event of the death of the insured is $100. This association is managed by a committee of employes and is entirely self-supporting, except that the company bears such overhead expenses as bookkeeping. The average amount of insurance carried per man is $13.16 a week, and on August 31 there were 417 employes of the company carrying insurance under this plan.

Safety, Sanitation, and Health Committee

In almost every case where successful results have been obtained in the elimination of working conditions which are likely to cause industrial accidents, a great point is made of the value of cooperation from men in the shop. Owing to the nature of the work which must be done in many plants, it is a hard matter to avoid the occurrence of accidents, and the nearest approach to absolute conditions of safety can only be obtained through the cooperation of the workers in the plant. In performing their daily tasks, the men will see the possibility of accidents occurring at points which have never been regarded as dangerous, and if they are interested in the work, their suggestions for the safeguarding of dangerous apparatus are most valuable. The same applies to the improvement of sanitary conditions and other matters that are likely to affect the health or general welfare of the workers.

To facilitate the work, there is a committee known as the Safety First Committee which meets once a week with the director of industrial relations and discusses with him the opportunities for improving any conditions in the plant which may appear to be unsatisfactory. There are eight members serving on this committee, whose duty is to not only make personal investigations of working conditions but also to gain the views of individual workmen as to the possibility of making improvements. The plant engineer is a permanent member of this committee, but other members of its personnel are changed every three months. The director of industrial relations is not a member of the committee but he is always present at its meetings. The committee selects its own successors, and a joint meeting is always held between the outgoing and incoming members. All meetings of the committee are held on the company's time.

Fig. 8. General View of the Auditorium in the Clark Theater which seats 1000 People

Conclusion

There are two general classes of labor to be considered in working out a plan of industrial relations for application in a manufacturing plant. One class consists of men of American birth who are thoroughly familiar with the institutions of our country; and the other comprises foreigners who have come to America to secure the benefit of more satisfactory living and working conditions than those existing in their native lands. American traditions require that men engaged in industrial pursuits should feel that they hold a position in the plants where they are employed that amounts to something more than a number on a time clock. It is with this idea in view that the Clark Equipment Co., and other firms who are solving their problems of industrial relations along similar lines, have worked out definite methods for the application of employes' representation, participation in profits, and the various forms of athletic and social activity, which have been described in this article. In order to judge the success of the plan, it is merely necessary for an experienced observer to go through the work-shops and observe the attitude of the men toward their work and the organization by which they are employed.

How Pattern Shop Practice Affects Core-Room and Foundry Methods

By JABEZ NALL

WHEN patterns are generally spoken of as applied to the production of castings, they are apt to be thought of as facsimiles of the part or casting to be produced. Whether or not this is true depends upon the simplicity or complexity of the design of the part. Sometimes the outlines of a pattern will be so changed by the addition of core-prints, etc., that the designer himself often fails to see in it the form of the casting that he desires to make. Then again castings may be made without any pattern, or anything considered as such. A core-box with a few change pieces added may be used to make a number of cores which when assembled will prove the most economical and best way, both in the pattern shop and the foundry, by which to attain the desired result.

Patterns should not be considered as completed articles in themselves, but should be regarded as tools, by the help of which the foundryman is enabled to produce satisfactory castings. As tools, they should be so designed and constructed that their maximum usefulness, strength, and ability to retain their shape may be attained, as well as their greatest general efficiency and lasting qualities under the work which they have to perform.

Cost Consideration in Making Patterns

The question of cost must also be considered, having the same ends in view. If a pattern is intended to be used but once, or only a few times, it would be unwise as well as a waste of time and money to finish the pattern highly or to add other unnecessary labor or material as a means of increasing its strength, beyond or above what is needed to attain the desired result. Indeed, sometimes it is true economy to save on the pattern, even if by so doing the cost in the foundry is increased, but this practice should not be carried too far because any repetition of the use of the pattern thereafter would tend to offset more and more the initial saving in the pattern shop. In machining castings, there are tools for common rough work and fine tools for precision work with special jigs to aid in quantity production, and in pattern work the same difference exists; this should be properly recognized and considered.

The cost for labor spent in trying to attain exactness of dimension, or an extra fine finish on a pattern that does not require it, is an absolute waste. However, there are cases which require this exactness and fine quality of workmanship. The cost of the patterns thus produced—when such care is necessary for obtaining quality and quantity production of castings—is good economy even though the initial cost may be high.

As fine tools are necessary in the production of precision work in the machine shop, so a fine set of exact, easily manipulated and well fitting patterns is necessary in the production of castings, the quality, appearance, and dimensions of which are required to be duplicates of each other. Fundamentally the patternmaker should be capable and willing to work in accordance with the use and requirements of the article which is ultimately to be produced. A poorly designed pattern or core-box will add largely to the cost of molding, and will probably result in the loss of castings. A few simple examples will illustrate the points made in the preceding paragraphs.

Example of Economy in Making a Simple Form of Core

In Fig. 1 at *A* is shown a core of half-round section of approximately 10 or 12 inches in diameter. It is a common practice at present (though not so much so as formerly) to make this simple type of core by the use of a skeleton or frame box, as shown at *B*. This practice is more frequently followed in cases where the diameter of the core is larger than in the present example. While this method effects a slight saving in pattern work and lumber over that of making a box such as shown at *C*, the saving is very small if proper use is made of the woodworking machinery and if all unnecessary hand work is avoided. Taking into consideration the fact that this saving occurs but once, the use

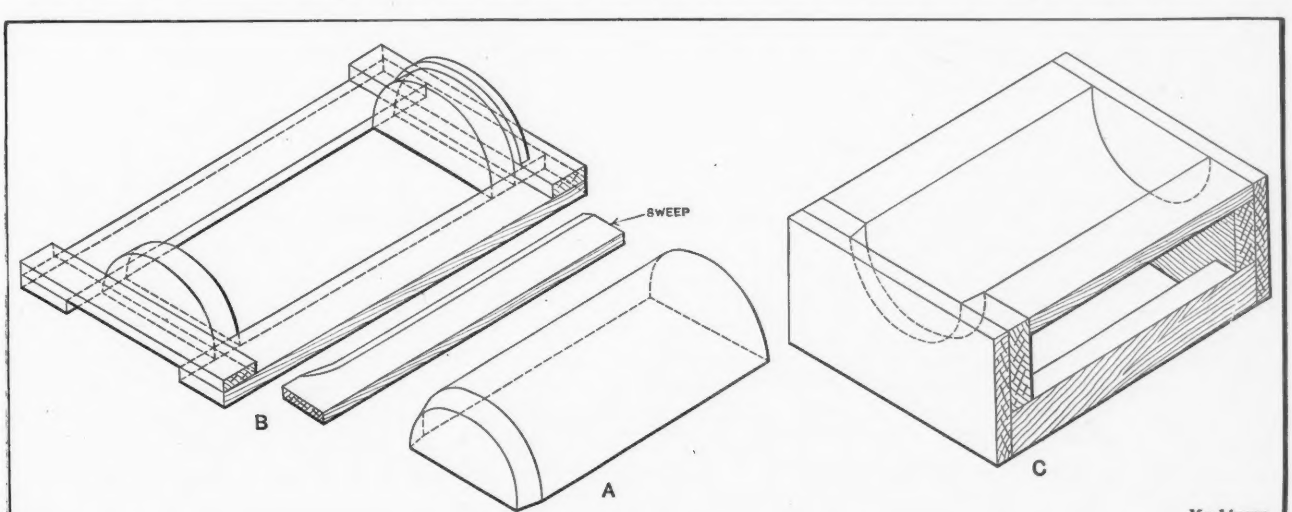


Fig. 1. Half-cylinder Core and Boxes in which it can be made

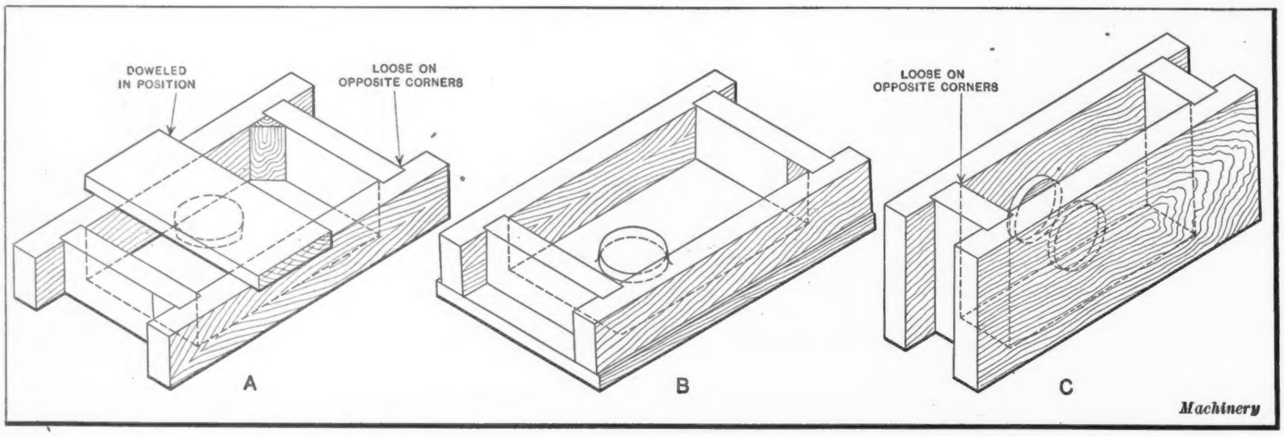


Fig. 2. (A) Poor Design of Common Core-box. (B) Improvement over Type of Core-box shown at the Left. (C) Design for Box having Bosses on Opposite Sides

of a skeleton is poor economy when it is considered that each time the box is used instead of the skeleton, a saving of from 300 to 400 per cent will be effected in the core-room, when the cores are made by hand. If a jarring machine is used, the difference will be still greater, for the cores will be more evenly rammed and more exact as to dimensions, if made in the box *C*.

There are other points in connection with the simple cylindrical core and its production that are not always given proper consideration by the patternmaker. Although there are various machines for producing cylindrical cores, it is often necessary to make cores of similar shape by hand, in which case it is quite common practice for patternmakers to provide a half-box. For cores of ordinary length (up to 16 or 18 inches and under about 6 inches in diameter) this is not good practice, when either accuracy or economy of production are considered.

To produce a cylindrical core from two pieces made in half-boxes, the coremaker must practically make two cores; he must also use two plates instead of one, thus using twice as much oven space; and there is also the consequent additional amount of handling. When the half-cores are dry and still warm they must be brought together, the joints must be cleaned off, and the cores must be fitted, calipered, and finally pasted and bound together. In the time thus consumed, a coremaker could have produced several seamless cores of accurate size and shape, if made in a cylindrical core-box and rammed from the end.

Efficiency in the Design of Common Core-boxes

A very common core-room tool is a box similar in design to the one shown at *A*, Fig. 2. This box is poorly designed for the work for which it is intended, and appears to be a misconception of the use of such a tool—the result of unfamiliarity with actual foundry practice. It does not save in pattern work, and is inconvenient to handle, requiring clamping together while being used. The boss must also be bedded in, the support of which prevents the quick striking off of the top of the box.

The solid or dump box shown at *B* in the same illustration is easier and more quickly made, requires no clamping, and being open at the face no tucking under is necessary, eliminating the possibility of the boss rising from its position unnoticed. This type of box insures a core of the right size, that can be made in the time that the coremaker would require to adjust the clamp on a box of the design shown at *A*. If a boss should be required on opposite sides of the casting, as is often the case, rather than add a bar with a boss attached to the core-box *B* (similar to the one on box *A*), better results will be had by changing the form of the box, so that the core is made on edge as shown at *C*. This box is loose on opposite corners and must be clamped together.

While these are but simple illustrations, they point to a fact that should be emphasized; namely, that patternmakers are often unfamiliar with actual foundry practice, or at least, do not give sufficient attention to details in the design of tools for the foundryman.

Cores for Molding a Self-oiling Bearing

An interesting molding job consists of casting a self-oiling pillow-block bearing, the pattern and cores of which are shown in Fig. 3. The pattern is shown at *A*, the main bearing core at *B*, while the core for the oil chamber is shown at *C*. The bearing itself is a steel casting, and presents a somewhat difficult problem in molding. Inasmuch as the oil-chamber cores, if made of the regular mixture of core sand, could

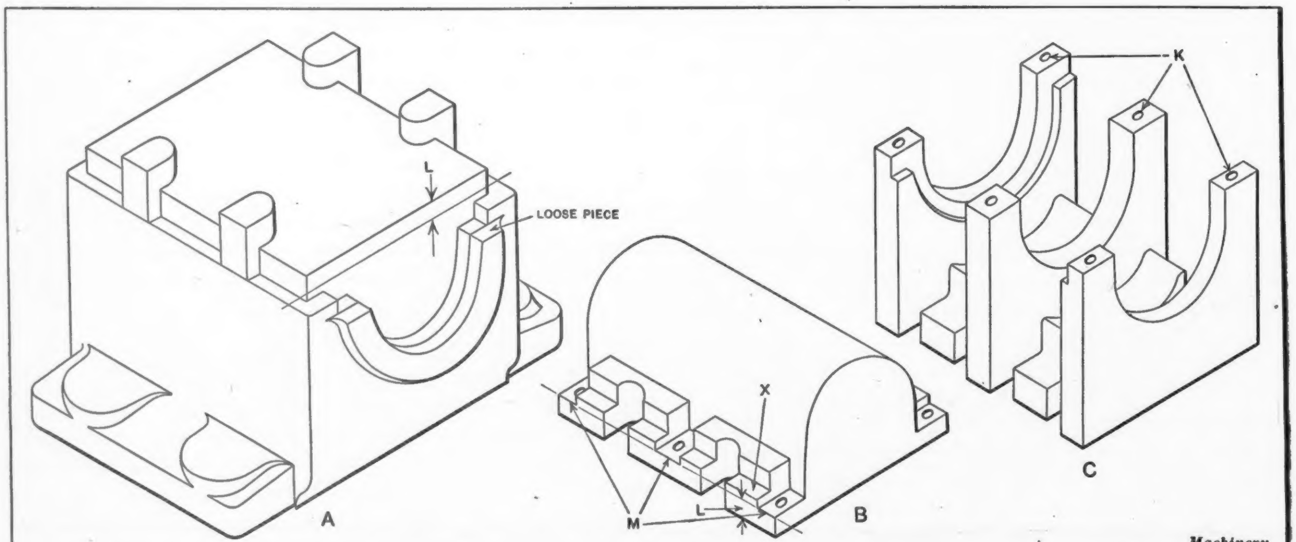


Fig. 3. Pattern and Core-boxes used in molding a Self-oiling Pillow-block Bearing

not be removed owing to the enclosed position, it was found necessary to form them of a very open, yet reasonably fine sand, with only a small proportion of loam, using oil only as a binder. This makes a core sufficiently strong to resist the pressure of the metal and the necessary handling, and one which, after being subjected to the heat of the casting, will pulverize under the shock of a hammer blow on the outside of the casting, or in the tumbling barrel. This mixture naturally generates a large quantity of gas, for the escape of which free and ample passages must be provided. If vents were not provided, the confined position of the core, which is almost surrounded by metal, would explode the mold.

To provide these air passages, wax vents ¼ inch in diameter are used, forming channels from the body of the core through each of the six passages as indicated at *K*, Fig. 3. When the cores are assembled as shown in Fig. 4, these vents

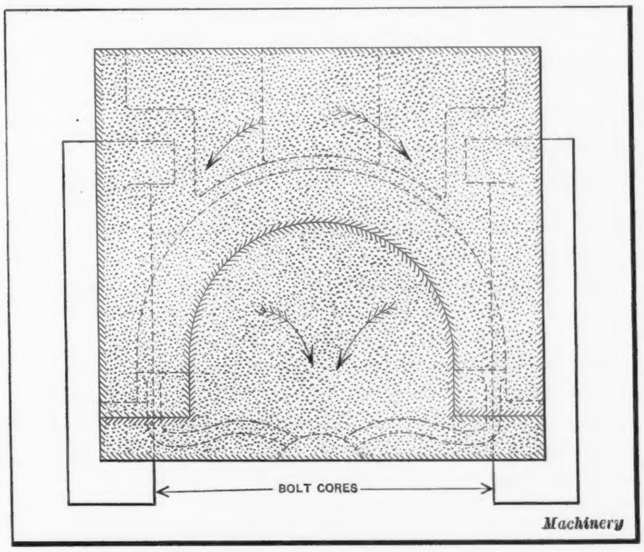


Fig. 4. Assembly of the Cores used in molding the Casting, the Pattern of which is illustrated in Fig. 3

from the oil-chamber core join other vents in the main bearing core, conducting these gases through the outside of the core-print and thence through the mold. The arrows in Fig. 4 indicate the general direction of the flow of the gases, which finally escape through a channel cut on the under side of the main bearing core.

As originally made, the prongs of the oil-chamber core rested on an even surface on the main bearing core, that is, on a surface in the plane of surface *X*, Fig. 3, but in casting, it seemed impossible to prevent a slight separation of the two cores under the pressure of the metal. This allowed the metal to flow into the vents, resulting in the loss of the casting, and creating a source of danger to the workmen. By adding about ¾ inch to the face of the core-print on the pattern, as at *L*, and raising the core-box of the main bearing core a corresponding amount, provision was made for forming recesses for the lengthened prongs of the oil-chamber core to rest in, as shown at *M*. This made it possible to seal these joints so that the metal could not run between them. Thus by this slight change in the design of the pattern, the danger to the molder was removed and no further trouble or loss experienced.

These illustrations show how essential it is that the patternmaker should have a thorough working knowledge of foundry conditions and practice. Owing to the fact that such a large proportion of the pattern work of today is done in job shops, sometimes far removed from the foundry, it is difficult for many patternmakers to obtain this knowledge first hand. For this reason, an attempt has been made in this article to set forth some important points relating to the effect on foundry practice of the methods employed in the pattern shop, and a careful consideration of these points should enable the patternmaker to produce patterns that will insure economical production in the foundry.

GEARS AND PINIONS FOR ELECTRIC RAILWAY SERVICE

At the meeting of the American Gear Manufacturers' Association in Boston in October certain rules covering the manufacture of gears and pinions for electric railway service were adopted as recommended practice by the members of the association. Railway gears have probably been standardized to a greater extent than gears used in any other field. This service can be divided generally into two classes—interurban and city service. The elevated and subway gearing can be grouped with the interurban. The standard pitch for interurban service has been set at not less than 2½, and for city service at not greater than 3. The standard face for interurban gears is 5 inches, and for city service 5 and 4½ inches.

The hub and bore dimensions for the gear are dependent to a great extent upon the American Electric Railway Association axle specifications. There are ten of these standard axles, E1 to E10, inclusive, covering all classes of service except trunk line electrification. The number of gear seat sizes have been reduced to six, 4, 4½, 5, 6, 7, and 8 inches. The length of gear hubs has been limited to two sizes, 4⅝ and 6⅛ inches. Two lengths of hub projections have been adopted which are 2⅛ inches on the motor side and 1 inch on the wheel side, also 1 inch on the wheel side and ⅛ inch on the motor side. The sizes of gear hubs have been reduced to five in number which are, 6½, 7, 8, 9½, and 10½ inches in diameter. The older designs of gears have several other sizes of hubs, and an attempt is being made to have customers bore out gear-cases to accommodate one of these standards. All solid gears are applied without a keyway with an allowance of 0.001 inch per inch diameter, this allowance being made in the bore of the gear. The pinion is applied with a taper bore tapering 1¼ inches per foot, which is now standard. The gear keyways have been standardized.

In conformity, as far as possible, with the American Electric Railway Association standards, the following limits for finish are recommended: The outside diameter over the teeth as machined must not vary from that specified by more than plus 0 inch or minus 1/32 inch. The face of the gears must not vary from the specified width by more than plus or minus 1/32 inch. The minimum thickness of the rim under the teeth shall be as follows, measured ⅛ inch in from the edge of the rim:

Pitch	Thickness of Rim
3	3/8 inch
2½	7/16 inch
2	1/2 inch

The web of all gears shall have four 3½-inch holes on a 7¼-inch radius spaced with a tolerance of ⅛ inch in the center of the webbed section, whenever the space will permit.

Dimensions of Bore and Hub

The diameter of finished bores shall not vary from that specified by more than plus 0.0015 inch or minus 0.001 inch. The diameter of the rough bore shall not vary by more than 1/16 inch over and ⅛ inch under that specified. The ends of finished bores shall be chamfered 1/16 inch on the motor side to avoid injury to the shaft when mounting. The diameter of the bores shall be measured with a pin gage or an inside micrometer.

The face of the hub shall have a smooth-bearing finish and run true with the bore. The variation from the specified dimensions of the hub and the hub extension shall not exceed the following: Length of hub over all, plus 0 inch to minus 0.02 inch; length of hub extension, plus 1/32 inch to minus 1/32 inch; diameter of hub extension, plus 0 inch to minus 0.03 inch.

The thickness of teeth at the pitch line must not be more than 0.01 inch under the size specified to allow for backlash. The teeth shall be of the Brown & Sharpe standard 14½-degree involute form unless otherwise specified.

All gears shall be tested for smooth running. The teeth must be equally spaced so that the gear will run smoothly

in both directions with a master pinion. Records of all chemical analyses and physical tests shall be kept by the manufacturer and shall be available to the purchaser for a period of one year. The purchaser reserves the right to reject any portion or all of the material which does not conform to the foregoing specifications in every particular.

Pinion Finish

The outside diameter of the pinion must not vary from that specified by more than plus 0 inch or minus 1/32 inch, measured at the center of the face. The face of the pinion must not vary from the specified width by more than plus or minus 1/32 inch. All bores must be finished after treatment. The diameter of the bore must be such that the standard plug gage will not project less than 1/32 or more than 1/16 inch, measured at the large end of the bore, and have bearing the full length of bore. All bores must be central with the pitch circle. All bores must have a reasonably smooth finish. The depth of the counterbore must not vary from that specified by more than plus 0 inch or minus 1/32 inch. The diameter of the counterbore must not vary from that specified by more than plus 1/32 inch or minus 0 inch.

The sides of the keyway must be cut parallel with the center line of the pinion. The width of the keyway must not vary from that specified by more than plus 0.003 inch or minus 0.0 inch. The depth of the keyway must not vary from that specified more than plus 1/64 inch or minus 0 inch. The fillet at the bottom of the keyway shall have 1/16 inch radius. Care must be taken to see that the pinion does not ride on the top or corners of the key. With this specification 1/32 inch clearance shall be provided for widths up to 7/8 inch, and 1/16 inch clearance for widths over 7/8 inch.

The thickness of teeth at the pitch line must not be more than minus 0.01 inch of the specified thickness. The teeth shall be of the Brown & Sharpe standard 14½-degree involute form unless otherwise specified.

Workmanship and Inspection

All pinions shall be tested for smooth running. The teeth must be equally spaced so that they will run smoothly in both directions with a master gear. All pinions shall be gaged with a standard taper plug gage, which shall be the same size as the nominal size of the bore at the large end. This plug gage must project not less than 0 or more than 1/32 inch, measured at the large end of the bore, and have bearing the full length of the bore.

All pinions shall be free from any seams, cracks, or other defects that would in any way affect their service. The purchaser reserves the right to reject any portion or all of the material which does not conform to the foregoing specifications in every particular.

Putting on Railway Motor Pinions

Many of the pinion failures on electric railway motors are caused by putting the pinions on incorrectly. It is generally believed that if a pinion is pushed on the shaft and the nut tightened, it will run satisfactorily without loosening. Experience has shown that in order to obtain satisfactory operation, pinions should drive their gears through the press fit or shrink fit on the shaft and not through the key. The key acts merely as a safety device should the pinion accidentally loosen. The desired fit for the pinion can be had by heating or by pressing.

Precautions Used when Putting Pinions on Shafts

The following points should be observed when putting pinions on railway motor shafts with a taper fit: The shaft should be clean and free from burrs or swellings; the pinion bore should be clean and free from burrs; the fit of the pinion bore should be in contact with at least three-quarters (75 per cent) of the surface of the taper fit on the shaft. This can be checked by rubbing Prussian blue, thin red lead and oil, or thin lampblack and oil on the pinion bore and fitting it on the shaft. After the above points have been taken care of the pinions should be put on the shaft cold to make sure that the keyway in the pinion is the proper size for the key mounted on the shaft, and that the pinion does not ride or bind on the top and sides of the key and will not ride the key when pressed further on.

The keyway on the pinion can be 0.002 inch larger, but not smaller than the key. There should be at least 1/64 inch clearance between the top of the key and the bottom of the keyway in the pinion. The corners of the key should be rounded to prevent their cutting into the fillet of the keyway.

Heating Pinions for Motors

Pinions up to three-inch bore should be heated in boiling water for thirty minutes, and those with three-inch or larger bore for sixty minutes. When the pinion has attained the temperature of the boiling water, namely, 100 degrees C. (212 degrees F.), it should be taken out of the water and the bore quickly wiped clean. Without allowing the pinion time to cool, it should be tapped on the shaft with a six or eight-pound sledge hammer, using a heavy piece of wood or copper between the pinion and the hammer. This sledging is not to obtain a driving fit, but to make sure that the pinion is home, and well seated. Three or four taps evenly distributed around the pinion end should be enough. The pinion nut with lock-washer can then be screwed home tight, with a wrench having a purchase or lever arm of three or four feet.

A suitable pinion heating arrangement can be easily made, the water being heated by an electric heater, a gas flame, or a steam coil. To prevent rusting and to insure a clean surface at the fit, washing soda should be added to the water in the proportion of one-quarter pound of soda to five gallons of water. By following these directions, it is possible to put pinions on armature shafts that will stay put and drive through their fit under the very hardest pulling from the motor.

* * *

HOTEL FOR EMPLOYES ERECTED BY THE NEW DEPARTURE MFG. CO.

Owing to the great difficulty of providing housing facilities for its unmarried employes, the New Departure Mfg. Co., of Bristol, Conn., has undertaken to build a hotel containing 300 rooms and intended to accommodate 600 men. The hotel is a five-story building, having bowling alleys, poolroom, and a barber shop in the basement; a large lobby with dining-room on the first floor; and sleeping rooms on the second, third, and fourth floors. The fifth floor will be fitted out as a club for the foremen, together with an assembly hall accommodating 300 persons. There will also be dining facilities on this floor, and a few guest rooms for guests of the company. The equipment throughout the hotel will be similar to that in the modern commercial hotel. In addition, the company has already built 100 houses, furnishing homes for 176 families, and is also interested in another real-estate enterprise which has constructed about 200 houses and is expected to erect as many more before the full building program is completed. The hotel and these houses are expected to take care of the present needs of the additional employes which the company expects to employ in the extensive additions made to its plant in Bristol.

* * *

The automobile industry is using a great amount of steel at the present time, and the requirements of automobile builders place a heavy demand upon the steel companies. The amount of steel consumed has greatly increased, since nearly all automobile bodies are made from sheet iron, and it is stated that the consumption of sheets of all kinds entering into the manufacture of automobiles is nearly 1,000,000 tons a year. The demand for steel in 1919 was from 20 to 25 per cent greater than during 1918, in spite of the fact that large quantities of steel were used in the latter year in building trucks for the Government.

Flush-pin Gages

By JOHN E. COLLINS

FLUSH-PIN gages are used for measuring the depth of holes, slots, counterbores, etc. This type of gage, in its simplest form, consists of a body *A*, Fig. 1, with a sliding pin *B*, which registers the depth of hole by means of a step on the top of the body. These gages are often mounted in holders of various designs and sizes, as illustrated in Fig. 2. The body should be made of machine steel, pack-hardened; the gage pins under ½ inch in diameter should be made of hardened tool steel, and those over ½ inch in diameter should be made of machine steel, pack-hardened.

In dimensioning flush-pin gages, care should be exercised in applying tolerances on the gages, and the standard type should be dimensioned as shown in Fig. 1. This type has no base attached, and therefore a minimum length of pin projecting beyond the body makes the opposite end of the pin come flush with the top of the step on the body. By giving the difference in tolerance allowed on the component to the bottom of the step, the maximum and minimum depths of the work may be readily gaged. This position is reversed on a mounted flush-pin gage; that is, the work rests on the gage bottom proper and is measured from the resting surface of the gage to the end of the pin, instead of from the lower end of the gage body to the end of the pin. The flush-pin gage shown at *C*, Fig. 1, is of correct design and is correctly dimensioned. Wherever possible, this type should be used, but if the pin should be too large to enter the work, a gage having the same size body but a smaller pin, as shown at *D*, is used. A variation of this type of flush-pin gage, as shown at *E*, meets the condition that arises in gaging a hole that is small in diameter and around which there is such a small area that the bodies shown at *C* and *D* would slide over the work instead of resting on its top surface. To take care of this condition, the body is counterbored, and a special pin with a slender end turned on it is used as shown in the illustration. Flush-pin gages are, in most cases, special, and for this reason usually require individual attention.

In Fig. 2 are shown two types of mounted flush-pin gages. The gage shown at the left has a movable spindle attachment. The type of work on which this gage is used is shown in section. The gage has a handle *A* which is used to lift the plunger *D* while the work is being placed in position for inspection. *B* is a pin mounted on a movable arm *J*, which may swing on the pivot *H* for convenience in loading cylindrical-shaped work. *C* is a stop-pin for limiting the swing of arm *J*. Blocks *E*, *F*, and *G* are held together by means of screws, and it is good practice to relieve block *F* about 1/32 inch on each side in order to obtain a perfect bearing surface between the blocks. Care should be taken to make block *E* high enough to provide a long bearing for pin *D*, so that there will be no danger of its wearing loose. The variation from the maximum and minimum limits is, of course, felt by the fingers on the top of pin *D*.

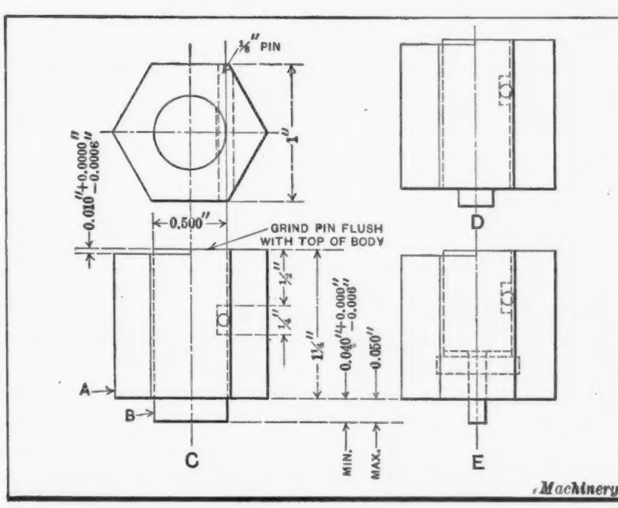


Fig. 1. Standard Types of Unmounted Flush-pin Gages

The type of gage shown at the right of Fig. 2 is used for measuring the distance from a counterbored surface to the bottom face of the work. *K* represents the outline of the work to be gaged. *L* is the base on which the work rests and to which the block *M* is attached. This block has two bearings for supporting the swinging bar *N*, on the end of which is a common flush-pin *O* that rests on the counterbored surface of the work. Rod *P* is the stop for bar *N* and supports it in the correct position. This rod should be hardened and ground on the end which bears against the bar. The dimension to be gaged is represented by *X*, and the manner of performing the gaging operation is so simple that no explanation is necessary. By making this dimension maximum it brings the pin to the top step of the body, and by giving the difference allowed in the manufacturing tolerance, the height of the step is found. Tolerances for the toolmaker which are allowed on the gage proper are applied in the opposite direction from those for the standard type of gage shown in Fig. 1. This mounted gage may be checked by the use of precision blocks or by making a special check, which in this case would be a hardened block made to the maximum dimension *X*.

Tolerances for Flush-pin Gages

Tolerances for flush-pin gages are taken from Table 4, published in the November number of MACHINERY, page 216, and are applied in the same manner as for plain gages. Referring to the dimensioned gage in Fig. 1, it will be noted that the general rule which can be applied to all limit gages having this system of tolerances is applicable in this case—that is, the minimum distance shows a maximum tolerance. Instead of giving the maximum distance a minimum tolerance, the tolerance is applied to the step on the top of the gage. This is done to give the toolmaker a tolerance on the last grinding operation, which will allow him a slight leeway, and at the same time enable him to produce a gage which is correct in gaging dimensions, as well as in direction of tolerance, so as to allow for wear of the gage in actual practice.

The method of final grind-

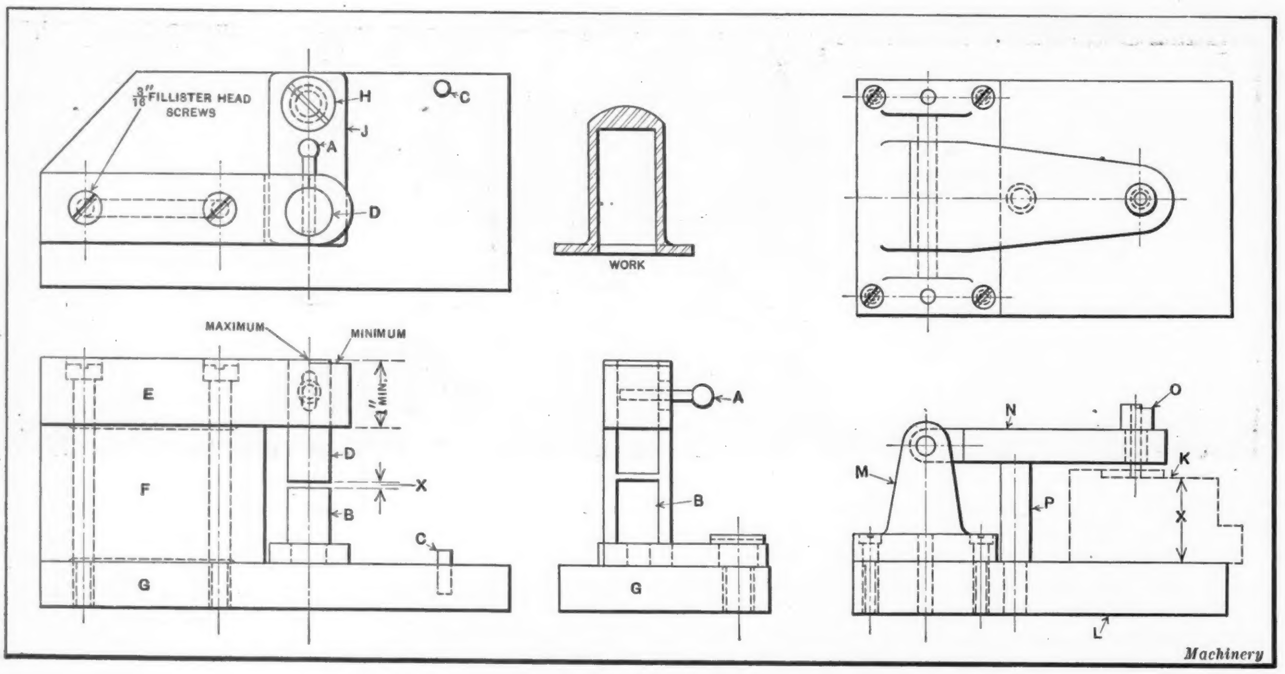


Fig. 2. Types of Standard Mounted Flush-pin Gages

ing and lapping for the step dimension (which is the last operation on the gage) is to set the body and pin in a suitable holder or vise on the grinding machine, with the minimum distance between the bottom of the gage body and the end of the gaging pin, correct to the dimension on the drawing. The tolerance for the minimum distance is taken advantage of and used to set the gage within the limits allowed. The tops of the body and of the gaging pin are then ground off together and lapped perfectly flat, as noted on the drawing. This gives one limit in the gage, and all that remains to be done is to allow the gaging pin to drop down out of the way, and grind the step proper to the minimum or "Not Go" tolerance as provided in the table previously referred to. This brings the gage within the prescribed limits.

Counterbore Depth Gages

Flush-pin gages of the type shown in Fig. 3 are used for gaging the depth of counterbored holes. The type shown at the left was developed for use on large holes, counterbored up to 5 inches in diameter, which have a close tolerance and must be measured from a shoulder on the outside of the work. The gage is bored to fit the diameter of this shoulder, with 1/64 inch clearance, and is then bored out for the pin gage body. The body is turned to fit the bore and pressed into the plate as shown in the illustration, after which the fitting surfaces are ground and the end of the gage body and the pins ground and lapped. This type of gage is inexpensive and will give accurate results to within 0.0015 inch.

The depth gage shown at the right in the illustration is for measuring the depth of counterbored holes from a flat surface. The shoulder *A* rests on the flat surface of the work and the foot *B* in the counterbore to be gaged. Any variation in the depth of the counterbored hole may be felt by placing the finger on the flush-pin and top of the gage.

* * *

I believe that the biggest problem industrial management faces today is the labor and production problem; it transcends in importance the sales and financial problems, and is worthy of the exclusive and direct attention of the chief executive.—*Charles Piez, President, Link-Belt Co., in an address before the Illinois Manufacturers' Association.*

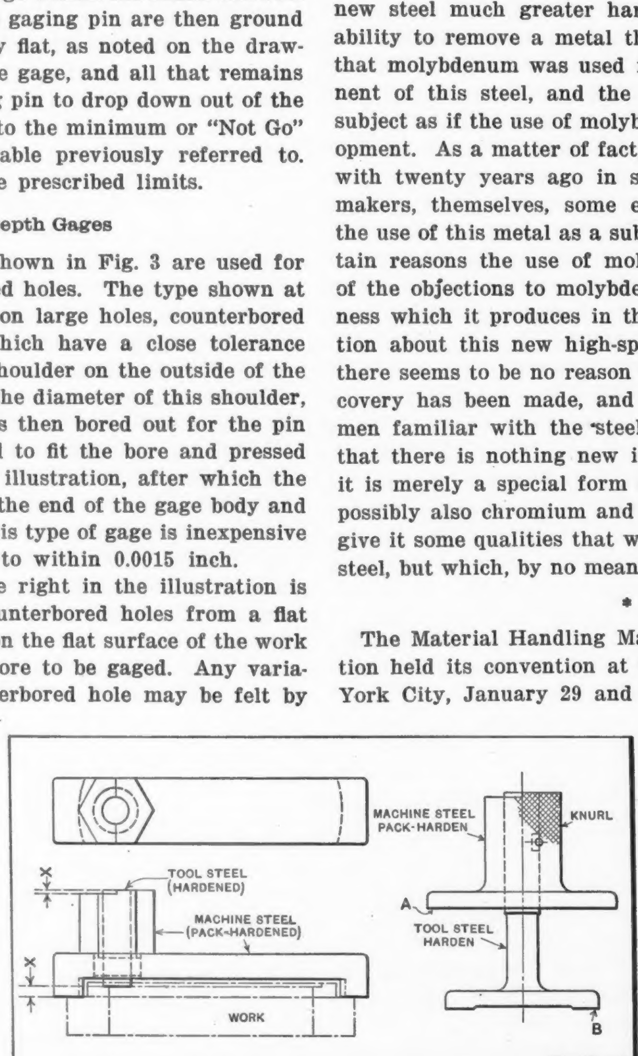


Fig. 3. Examples of Two Types of Counterbore Gages

NEW MOLYBDENUM HIGH-SPEED STEEL

A short time ago, Professor John Oliver Arnold, of Sheffield University, Sheffield, England, made some startling statements with regard to a new steel that he claimed had been developed in Sheffield and which was said to be superior to any high-speed steel hitherto made. He claimed for this new steel much greater hardness, longer life, and greater ability to remove a metal than any other steel. He stated that molybdenum was used instead of tungsten as a component of this steel, and the newspapers commented on the subject as if the use of molybdenum in steel was a new development. As a matter of fact, molybdenum was experimented with twenty years ago in steel making, and English steel makers, themselves, some eighteen years ago investigated the use of this metal as a substitute for tungsten, but for certain reasons the use of molybdenum was abandoned. One of the objections to molybdenum is stated to be the brittleness which it produces in the steel. Until further information about this new high-speed steel is received, therefore, there seems to be no reason to anticipate that any great discovery has been made, and it is generally believed among men familiar with the steel business in the United States that there is nothing new in the steel announced, but that it is merely a special form of molybdenum steel containing possibly also chromium and vanadium, which would tend to give it some qualities that would be valuable in a high-speed steel, but which, by no means, are new or unknown.

* * *

The Material Handling Machinery Manufacturers Association held its convention at the Waldorf-Astoria Hotel, New York City, January 29 and 30. At the meeting a business session was held in the morning of January 29, followed by a formal luncheon at the hotel. In the afternoon, there was a session at which short papers on mechanical handling were read, followed by open discussion and moving pictures. An executive session of the membership was held during the following day, and papers on mechanical handling were again read, followed by discussion and moving pictures.

LETTERS ON PRACTICAL SUBJECTS

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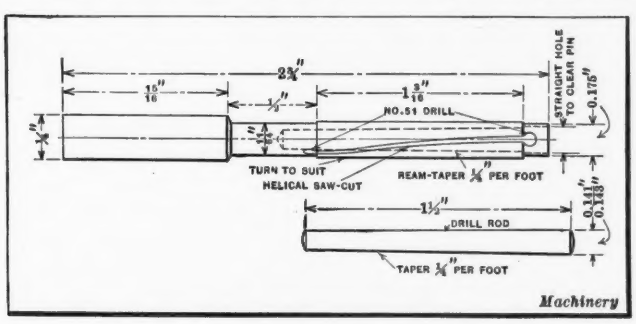
INTERNAL LAP

The writer has learned by experience that an internal lap made according to the design shown in the accompanying illustration is especially suitable for use in lapping small holes which are long in proportion to their diameter. The following information should be of assistance in making laps of this type. It is the opinion of the writer that copper is the most suitable material to use in making the laps. It will be noted that the lap is necked between the handle and the body and that the end is turned down in a similar manner.

Two holes are drilled through these necks, as shown, being connected by a helical saw-cut—a feature which prevents the hole from being lapped out of round and also provides for removing unevenness caused by hardening. The end of the lap is drilled out to a depth equal to the length of the turned portion, so as to clear the large end of the tapered pin when the lap is expanded. The diameter of the tapered pin in relation to that of the body of the lap should be such as not to leave the metal surrounding the pin so heavy that it will not conform to the taper of the pin when the lap is expanded.

This lap has been used for lapping holes 0.185 inch in diameter, 1¼ inches long, and sufficient accuracy has been obtained to make it impossible to enter a 0.185-inch diameter plug either dry or by using ordinary oil, but with oil which had been used it was found possible to get the plug into



Internal Lap which is especially suited for lapping Small and proportionately Long Holes

the hole. As an experiment, a plug was made 0.0001 inch over size and this plug could not be pushed through, no matter what kind of oil was used. In lapping the hole, no extraordinary care was taken, a fact which clearly demonstrates the satisfactory results which can be obtained with a lap of this design. Previous to making this lap, a slit bushing was tried on a tapered arbor but without success, because it was found that the lap expanded much faster on the large end of the arbor than on the small end. Under these conditions, it was impossible to obtain a straight hole or to prevent bell-mouthing.

East Hampton, Conn. HOWARD HOUSE

INTERCHANGEABLE JIGS AND FIXTURES

The writer has often heard remarks pertaining to jig and fixture design, such as: "Don't try to use the same fixture for more than one operation if it is necessary to apply loose parts or reset the fixture"; or "You will not obtain accurate results, if you expect the operator to set up that tool." These remarks are perhaps justified, if the tools are intended for an established article or machine, and provided the expense involved in making them is not a deciding factor. But, if they are intended for a new machine, which may be altered or redesigned in a short time, it seems advisable to economize on tool expense, and build fixtures that can be used

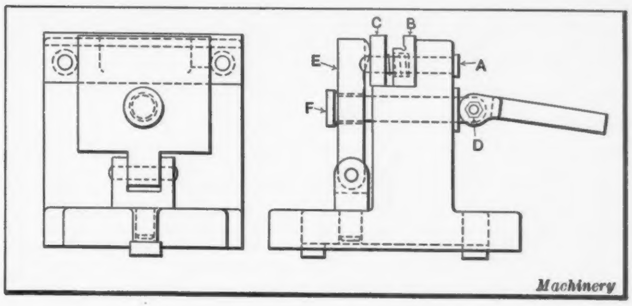


Fig. 1. Milling Fixture having Loose Jaw

for more than one part or operation. Of course, this practice should not be employed when production would be cut down to any great extent by tying up the fixture on one operation when it would be needed for some other operation.

Interchangeable jigs and fixtures should not be taken apart or changed by the operator, but should be returned to the tool-room after each operation, where they may be reset by an experienced mechanic. The fixture should be designed in such a way that when it is properly set, it cannot become easily changed either by accident or intention, except by the mechanic who is responsible for setting the fixture. The fixture should have dowel-pins or other fixed locating members so that the mechanic can reset it without using measuring instruments. Each fixture should be provided with an instruction sheet or diagrams showing the exact location of each loose part for the various operations for which the fixture is designed. The illustrations show several interchangeable jigs and fixtures which have proved useful in drilling and milling operations.

The most common type of interchangeable fixture is, perhaps, the ordinary milling vise that is provided with loose jaws and cam-clamping arrangement. This type of vise is satisfactory where extreme accuracy is not required, but the loose jaws do not always retain their accuracy of alignment or properly line up with the base if subjected to rough treatment. The fixture shown in Fig. 1 is a plain, inexpensive fixture with self-aligning jaws, which can be used instead of a milling vise on work requiring considerable accuracy. The two guide pins *A* are driven tightly into the base casting and the stationary jaw *B* fits snugly on these guide pins and is also fastened to the casting with screws. The loose jaw *C* is a sliding fit on the pins and

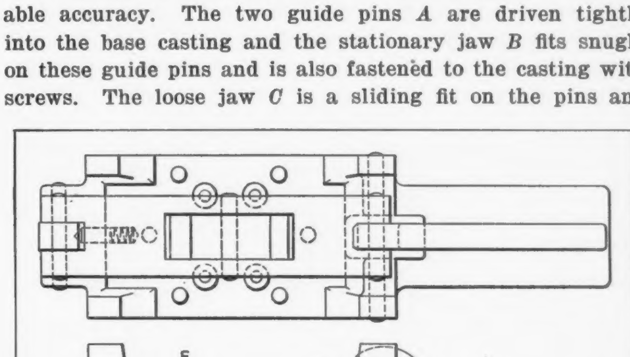


Fig. 2. Interchangeable Drill Jig

is held open by two springs when released by the cam. In order to change the jaws, the nut and pin at *D* must be removed, the bolt *F* withdrawn, and the clamp *E* opened, after which the jaws may be removed.

The drill jig shown in Fig. 2 is well adapted for drilling right- and left-hand pieces of similar shape which have the same size holes located in corresponding positions. Suitable locating pins should be provided on each side of the jig body, *A*, those on one side being used for locating the right-hand piece and those on the other side for locating the left-hand piece. The clamping leaf *D* which is equipped with an equalizer *E* is connected with the body by means of a link *B*. In this link are milled two notches which engage with the detent *C*. The detent is operated by a spring which holds the link and the clamping leaf in the desired position for drilling either the right-hand or the left-hand piece. If the jig is too large to make this spring detent arrangement effective, a more substantial screw-locking device may be substituted. This style of drill jig is especially valuable where it is essential that the holes in the right-hand piece line up perfectly with the holes in the left-hand piece.

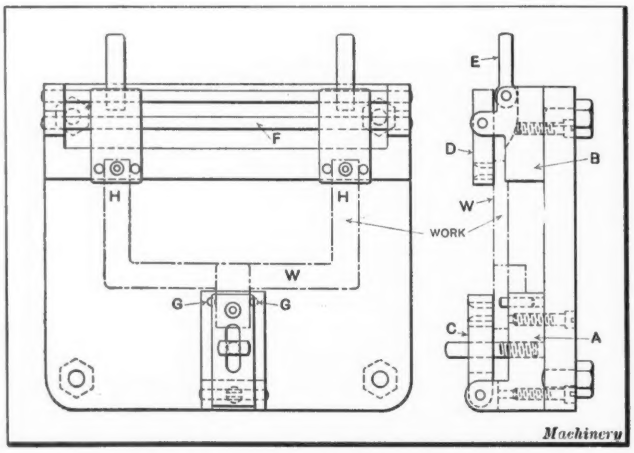


Fig. 3. Jig for drilling Eight Different Brackets

In Fig. 3 at *W* is shown one of eight steel brackets that are drilled in the jig illustrated. All the brackets have similar profiles, the only difference being in the number of fingers *H* and the distance between the holes in the fingers. The work is located on the two steel blocks *A* and *B* by the two pins *G* in block *A*, and is then clamped in place by the bushing leaf *C*. Two bushing leaves *D* or as many as any one bracket has fingers, are mounted on a rod *F* which is of sufficient length to suit the widest bracket. These sliding leaves each carry two locating pins which straddle the work, thus bringing the leaves into the proper drilling position. The sliding leaves are clamped down by the cams *E*, which move freely on another rod and are backed up by the steel block *B*.

It was necessary to locate several arms in different positions on shafts of various lengths, drill and taper-ream the arm hubs, and drive in the dowel-pins. Building a separate drill jig for each shaft, was expensive, so it was decided to make one jig with adjustable parts. This drill jig is shown in Fig. 4 loaded with a shaft having three arms. The base is made long enough to adopt it for the longest shaft, and a sufficient number of blocks *A* are provided to handle the shaft having the greatest number of arms. Two set-up plates *B* and *C* are made for each shaft and provided with square notches for locating the blocks in correct relation to each other and to the stop *D*, which is doweled to the base. When drilling a shaft, the proper set-up plates are fastened to the sides of the base, and the blocks, which are numbered to correspond with the numbers on the plates, are put in place and screwed down tight, thus forming a rigid jig for the shaft. The arms are now slipped on the shaft and the jig is loaded. Each block *A* carries slots and stops for locating the arms, and the shaft rests in a vee and is clamped against the stop *D* by the wing-screw *H*. The clamps *E* are next pushed into position, and the work is clamped down. The bushing leaves *F* are tightened, so that they rest on the shaft. The holes are then drilled, the leaves opened up, the holes taper-reamed and the dowel-pins driven in, after which the finished shaft is ready to be removed from the jig.

Hartford, Conn. SVEND HELWEG

PRECISION DEPTH GAGE

In small-arm cartridges, such as the 0.30 and 0.45 caliber and the 110 grain precussion primer, it is essential that the primer cap does not project beyond the rim of the cartridge case. The depth gage here illustrated was designed for the purpose of expediting the inspection of these parts and also to insure accuracy. The gage is of interest-

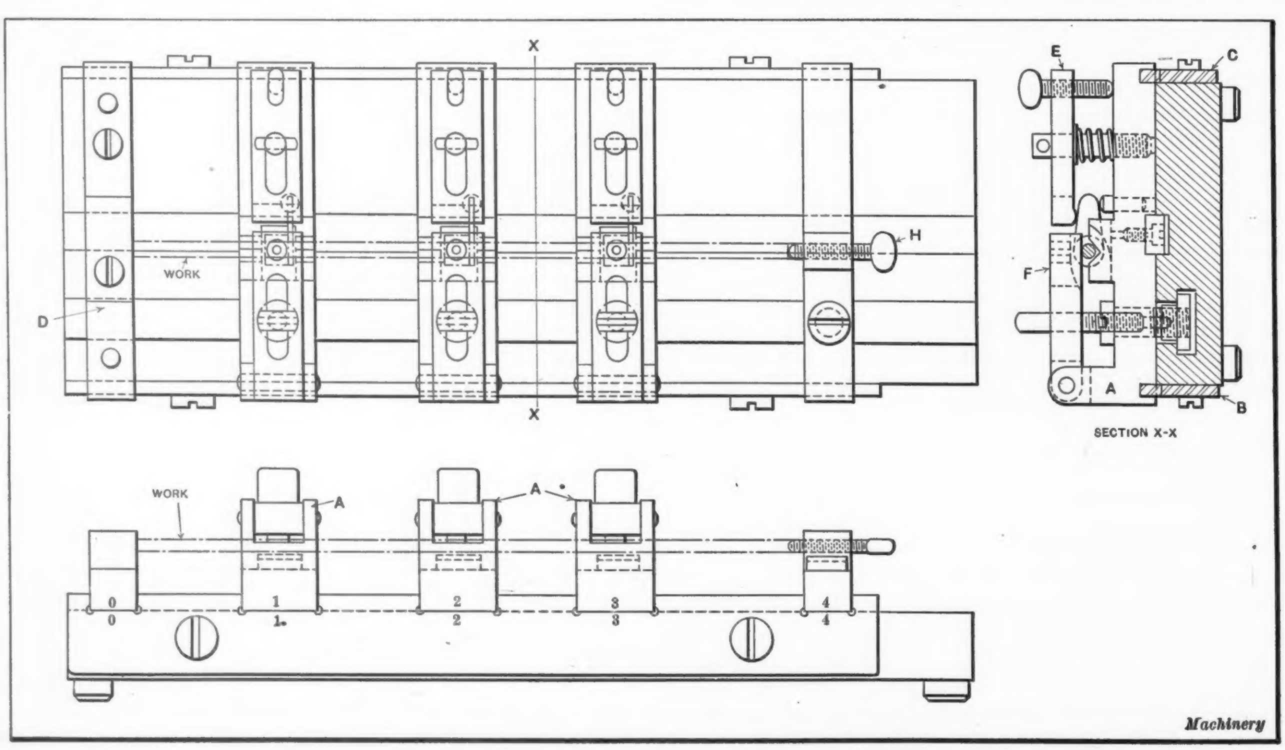
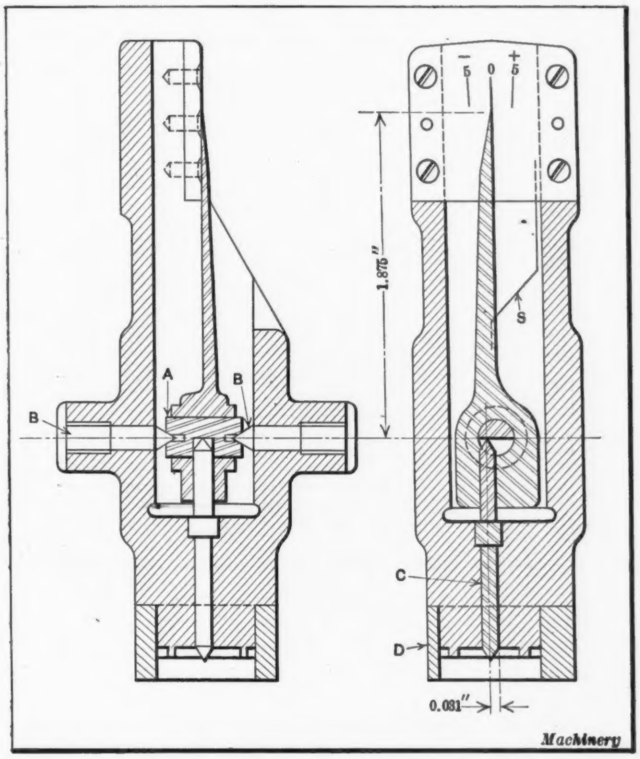


Fig. 4. Jig for locating and drilling Arms on Shafts of Similar Design



Precision Depth Gage with Graduations on a Scale of 60 to 1

ing design from the standpoint of the principle involved, and with modifications may be used for similar purposes.

The body is made from solid stock, turned, shaped, and bored as shown. The indicator arm is mounted upon a hardened steel arbor *A* in each end of which is a ground and lapped 60-degree female center. This arbor is ground on the outside and is a press fit in the hub of the indicator arm. The male centers which support the arbor are made of hardened tool steel and are ground and lapped, and provided with a threaded section for ease of assembling and adjustment. The arbor is also provided with a slot cut to a depth of one-half its diameter at right angles to its longitudinal center line. The bottom of this slot, which is the bearing surface for the plunger point, is accurately lapped. The center line of the plunger *C* is offset in relation to the center of the arbor an amount depending upon the degree of magnification desired. As will be seen, the offset in the gage illustrated is 0.031 inch, and the length of the arm, 1.875 inches, which gives a reading magnified more than sixty times. The reading is obtained on the graduated plate at the upper extremity of the indicator arm, the 0.005 inch graduations with this ratio being nearly 5/16 inch apart, and the 0.001 inch graduations being 1/32 inch apart. In the design shown, the graduations are so located that a plus or minus reading can be obtained. However, for this particular class of inspection, if the assembled primer cap projects beyond the rim of the case so that the gage registers on the plus side, or if the minus reading is below 0.005 inch, the cartridge would be rejected. The flat spring *S* shown at the right counteracts the tendency of the weighted end of the indicating hand to seek a vertical position, keeping it on the minus side when the gage is at rest and exerting sufficient pressure to force the plunger downward. The eccentric sleeve *D* at the bottom of the gage acts as a centering and retaining ring for the work to be gaged, and is pressed on the body. All movable parts of the gage can be readily replaced as required, and the bottom of the body proper can be finished down to compensate for the wear on the plunger, thus prolonging its usefulness.

The cartridges are inspected very rapidly and accurately with this gage. The instrument is held in one hand while the parts to be gaged are held in the other hand, and a variation of 0.001 or even 0.0005 inch can be readily detected.

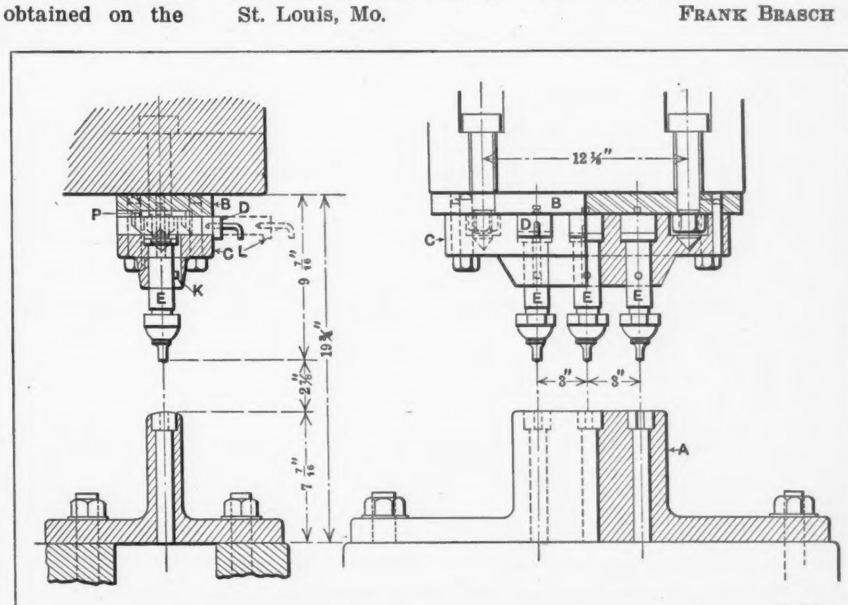
Plainfield, N. J. J. B. CONWAY

MULTIPLE PUNCH

One of the many varieties of multiple punches is shown in the accompanying illustration. Generally no provision is made in the design of multiple punches whereby any single punch in the gang may be rendered inoperative. This particular design, however, does contain this feature, and in consequence is especially suited for car-shop work, such as that requiring holes to be punched in channel iron in groups of two or more holes, where such holes are located at various intervals. The punch as illustrated is equipped for punching three holes 3/4 inch in diameter. The stroke of the machine on which this punch was used is 3 inches.

The die-block *A* is bolted to the bed of the punch press and is made of cast steel. It is drilled through and counterbored, as shown, to the proper size for receiving the dies. The toolpost holder block *B* is made of open-hearth steel 1 1/2 inches thick, 5 3/4 inches wide and 18 1/4 inches long and is secured to the ram of the machine as shown. The toolpost holder *C* is attached to this block by means of capscrews and dowel-pins. The punches *E* are prevented from rising when in operation by means of sliding keys *D*, one of which is provided for each punch. The keys have a lip *L* at one end and a pin *P* at the other end and these act as stops to prevent the keys from being entirely pulled out or from being pushed in beyond a predetermined position. Pins *P* operate in grooves in the blocks *B* when the key in which the pin is carried is moved. The keys *K* in the punches operate in keyways in the toolpost and permit the punches to be raised to an inoperative position when so desired; these keys also prevent the punches from turning when in operation. The construction of the punches proper should need no detailed description, as they follow the well-known standard type. As previously stated, it is possible to use as many of the punches in the gang as desired. To put a tool into an inoperative position, it is necessary only to move the key *D* to the position shown dotted in the illustration, which will allow the punch to be raised into the space formerly occupied by the key.

St. Louis, Mo. FRANK BRASCH



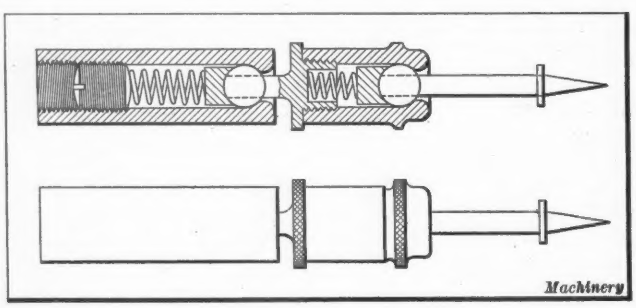
Gang Punch with Provision for independently placing the Punches into Operative Position. Equipment of this Design is used extensively in Car-shop Work

UNIVERSALLY JOINTED TOOL FOR LOCATING BORED HOLES

In the accompanying illustration is shown a device known as a "wiggler," which has recently become recognized as a necessity in certain classes of machine shop and tool-room work. The ease and accuracy with which bored holes can be located with the aid of this device is well known and appreciated. The tool shown in the accompanying illustration, however, is an improvement over the ordinary type. It consists of a double ball-jointed pointer which is of the usual design except that it has a collar pressed on at the indicating end and located about 3/8 inch from the extreme point. This collar or flange is ground to an outside diameter of exactly 1/4 inch and, of course, must be exactly concentric with the axis of the pointer.

When the tool is used to locate a hole in relation to a finished surface, the shank is held in a chuck on the spindle of a milling machine. By means of the double-jointed arrangement the pointer can be readily adjusted to run true, after which the table on which the work is clamped is brought up carefully until the edge of the flange just skims the finished surface, care being taken not to disturb the adjustment of the pointer. In this position, the center of the machine spindle is exactly 1/8 inch from the locating surface in a perpendicular direction, and it is then only necessary to use the micrometer dials on the table to determine the location of the required point on the face of the work. By the substitution of a boring tool for the locating tool in the machine spindle, the hole can then be bored and, if the milling machine is in good condition, a high degree of accuracy can be attained.

P. R. H.



Tool used in the Spindle of a Milling Machine for locating Bored Holes

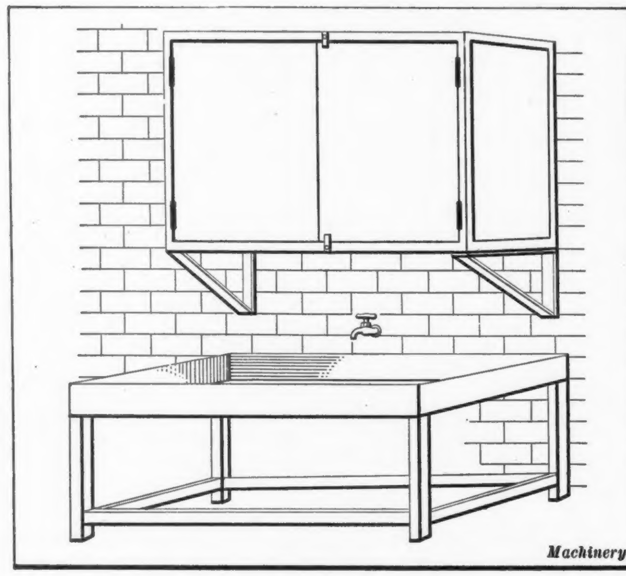
TRUCK FOR MOVING SHOP TOOLS

The use of rollers and skids for moving shop tools is fast being supplanted by the more convenient method of using trucks. This method is also much easier, cheaper, and quicker. A suitable truck for this purpose is one that is about 6 inches high, 4 feet wide, and 8 or 9 feet long, having four wheels 4 inches in diameter with a 4-inch tread. When a machine is to be moved, one end is simply jacked up and the truck slipped underneath. After the machine has been loaded, it is an easy matter to move the machine to its desired location, and this does not require the services of as many men as would be needed by the use of rollers and skids for the purpose.

Cicero, Ill. J. J. Borkenhagen

BLUEPRINT WASHING AND DRYING OUTFIT

A compact arrangement for washing and drying blueprints is shown in the accompanying illustration. It consists of a zinc tank which rests on a wooden framework, 2½ feet high, and a drying stove supported directly above the tank. The washing tank is 5 feet long, 3½ feet wide, and 6 inches deep, to which the water is supplied by a tap. A waste pipe is fitted at one end, the tank being slightly tilted to give the necessary drainage. The stove is 5 feet long, 1½ feet wide, and 3½ feet high, and it has a timber frame which is lined with asbestos sheeting, the bottom sheet being perforated to allow the water to drip from the prints into the tank. The stove is rapidly heated by means of electric heaters, one being attached in each end. The prints are hung on laths which are fixed in racks at each end of the stove. This outfit has been in successful operation for over a year.



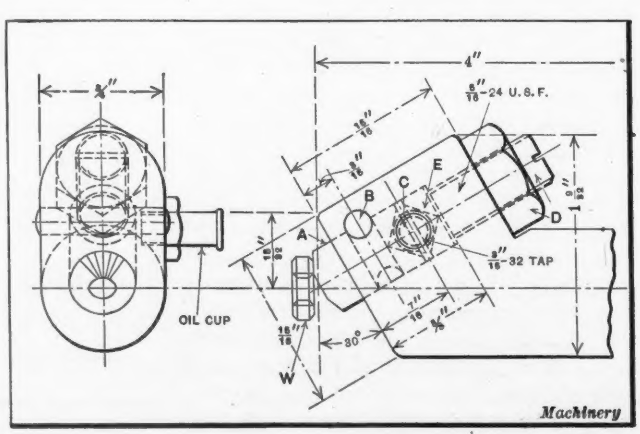
Blueprint Washing and Drying Outfit

Toronto, Canada James B. Nelson

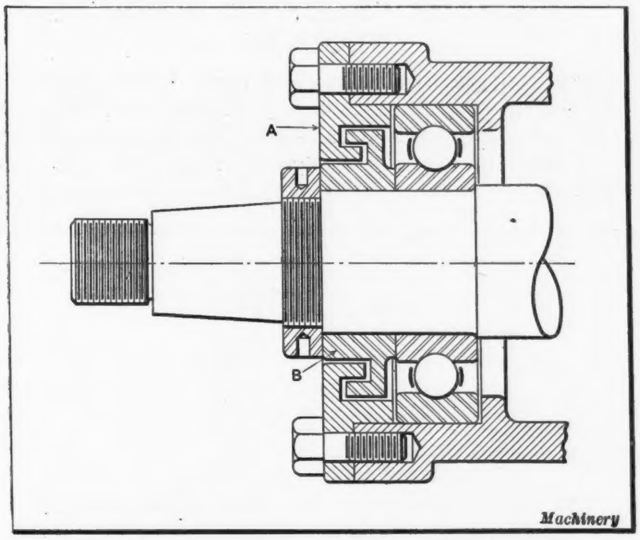
END-KNURLING TOOL

The end-knurling tool here illustrated was designed for use on an automatic screw machine and has given entirely satisfactory results. In this illustration, *W* represents the type of work on which this tool was used. The design is quite simple. The tool proper *A* is made of nickel steel and is provided with a circular groove in which the pin *B* engages to hold the tool in place and to permit it to revolve. The end thrust of the tool is taken by a steel ball *C* located in a conical recess in the end of the tool and held in place by a solid washer *E* having a similar recess. A set-screw *D* fitted with a lock-nut may be employed to compensate for wear of the ball and its points of contact in the two enclosing recesses. An oil-cup is provided as shown so that the ball may be readily lubricated, thus reducing to a considerable extent the amount of wear caused by friction. The shank of the tool-holder may, of course, be made to fit the turret of any screw machine, but the tool shown in the accompanying illustration was designed particularly for use on a Brown & Sharpe type of machine.

Buffalo, N. Y. H. Kurzweil



Automatic Screw Machine End Knurl



Ball and Roller Bearing Closure applied to Annular Ball Bearing

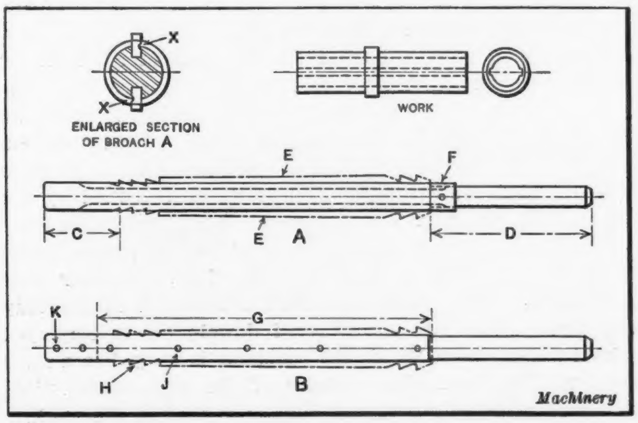
ENCLOSURE FOR BALL AND ROLLER BEARINGS

A device for the closure of ball and roller bearings for the purpose of protecting them from dirt and loss of lubricant is shown in section in the accompanying illustration. The application of the device to an annular ball bearing installation is clearly shown, as well as the rings which form the protection for the bearing. It will be noted that there are two of these rings, in both of which concentric grooves of rectangular section are turned. The groove in the face of the outer or stationary ring *A* receives the tongue of the inner or rotating ring *B*. The clearance between the sides of the tongue and grooves should be about 0.005 inch, and 1/16 inch space should be allowed for end play of the shaft. This space is clearly shown in the illustration. The protection afforded by this arrangement is remarkably good, even under the most adverse conditions, and is distinctly superior to the protection afforded by the use of felt washers, so commonly employed for this purpose. P. R. H.

KEYWAY BROACHES WITH INSERTED TEETH

The accompanying illustration shows two designs of inserted-tooth broaches which may be employed for broaching keyways in thin sleeves such as shown in the upper right-hand corner of the illustration. The broaches are of the push-through type; consequently the sleeves are held in a vertical position in a suitable fixture so as to allow the broaching tools to fall through the work after the keyways have been cut. The fixture is equipped with a hardened and ground steel bushing in which the body of the sleeve fits and against which its shoulder rests.

The tool shown at *A* in the illustration has two strips of cutting teeth *E* which are set in grooves milled in the shank and held in position by cutting a shallow groove *X* along one side of the strips and then peening the metal of the shank into these grooves as shown in the enlarged sectional view. A small collar *F* is pinned to the shank as a stop for these strips, the arrangement being entirely suitable for the small work for which broaches of this type are intended. One objectionable feature of the tool is that the strips of teeth cannot be removed without ruining the shank. The length *C* of the shank acts as a pilot in the bushing and the opposite end *D* is reduced in diameter so that it will readily fall through the work at the completion of the operation.

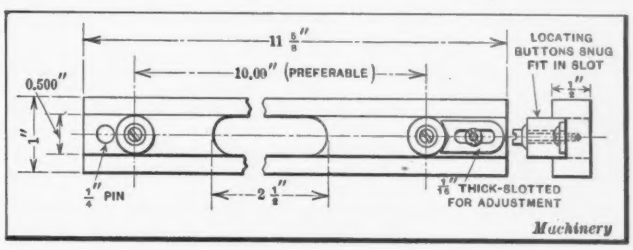


Inserted-tooth Broaches for Light Work

The broach shown at *B* contains but one set-in strip *H*, which fits into a slot cut through the shank and which is held in place by means of small pins *J*. This strip, as will be seen, has two sets of cutting teeth. The slot in which this strip fits is cut from the pilot end of the body to a depth suitable for the length *G* of the strip, the end of the slot *K* being closed with a filling strip, which is held in the slot by means of two small pins. This construction enables the cutting strip to be replaced when necessary by simply driving out the pins and substituting new strips of teeth. The latter construction is an economical method of making broaches of this type which, it should be mentioned, are intended to be used on an arbor press and for light work only. F. H. M.

ADJUSTABLE SINE BAR

The sine bar shown in the accompanying illustration possesses an adjustable feature which does not detract from its accuracy when employed to locate work and which greatly expedites the locating of the buttons. The design is not elaborate, and the only part that requires accurate machining is the ½-inch groove in which the buttons are located. The ground and lapped buttons must be a snug fit in this groove, the latter, of course, being parallel with the side of the bar. A ¼-inch pin is employed as a stop for the non-adjustable button and a 1/16 inch thick adjustable stop is provided for the adjustable button. This provision enables the toolmaker to remove and relocate the buttons when required and to reset them without difficulty. The fact that only longitudinal adjustment is needed greatly enhances the value of the tool. Of course, if so desired the adjustable stop may be eliminated and only the groove made use of, but the adjustable stop is the feature which should especially commend this sine bar. If an angle-plate having a vertical slot is used in connection with the sine bar, the 2½-inch slot in the bar will provide a ready means for bolting the sine bar in place after the work has been properly located by means of the buttons.



Sine Bar having Adjustable Feature for facilitating the Location of Buttons

Muskegon, Mich. George L. Garvin

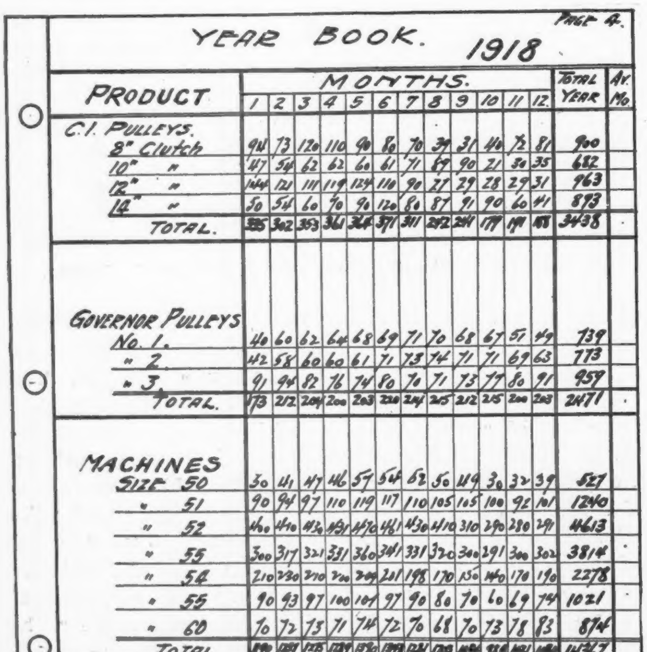
RECORD OF SALES

It is of great value to executives of manufacturing concerns to have reports available for constant reference, showing the amount of goods sold or the number of units disposed of within certain periods of time. The most common unit of time used in making these studies of sales is the month. Such reports will furnish the production manager or planning and routing engineer sufficient data upon which the schedules of production may be based. With the present high

cost of material, a minimum amount of work in progress and of stock on hand, compatible with good service and prompt delivery, is the best and most efficient method of doing business. An accurate report of the amount of goods sold is of great value to executives who are interested in watching the trend of sales, and is also useful to shop superintendents and foremen who are required to plan the production in sufficient quantities to supply the demand.

A large manufacturing company has evolved a simple plan for keeping executives and shop officials posted on sales requirements by making up what is termed a year book, a sample page of which is here illustrated. These pages consist of forms drawn on tracing cloth, on which the information is tabulated from month to month. Blueprints of these pages are bound and issued quarterly to the executives. Before issuing these quarterly statements, the folio already in the hands of the executives is recalled, the new quarterly statement is inserted, and the folio is returned intact. Thus, at the end of each year, the executives have a folio containing a complete synopsis of the year's business, which is easily accessible when rapid calculations and planning for future business demand such information. This report does not give prices, but simply states the quantity and kind of product sold.

Should information of this nature be desired at times other than the date of the quarterly statement, the executive has only to make his request to the proper clerk, and forthwith prints of the year book are made and sent to him. The data for the book are compiled from copies of customers' invoices, which are analyzed by filing in a box sub-divided in such a way as to give the desired information. Analysis is made and the information derived therefrom is tabulated



PAGE 4.

YEAR BOOK. 1918

PRODUCT	MONTHS 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL YEAR	AV. No.
C.I. PULLEYS.														
8" Clutch	94	73	120	110	90	80	70	39	31	40	72	81	900	
10" "	47	54	62	62	60	61	71	89	90	21	30	35	682	
12" "	144	121	111	119	124	110	90	27	29	28	29	31	963	
14" "	50	54	60	70	90	120	80	87	91	90	60	41	893	
TOTAL.	335	302	353	361	364	371	311	272	241	179	191	188	3438	
GOVERNOR PULLEYS														
No. 1.	40	60	62	64	68	69	71	70	68	67	51	49	739	
" 2.	42	58	60	60	61	71	73	74	71	71	69	63	773	
" 3.	91	94	82	76	74	80	70	71	73	77	80	91	959	
TOTAL.	173	212	204	200	203	220	214	215	212	215	200	203	2471	
MACHINES														
SIZE 50	30	41	47	46	57	54	62	50	49	30	32	39	527	
" 51	90	94	97	110	119	117	110	105	105	100	92	101	1240	
" 52	400	410	430	431	470	461	430	410	310	290	280	291	4613	
" 55	300	317	321	331	360	341	331	320	300	291	300	302	3814	
" 54	210	230	210	200	209	201	198	170	150	140	170	190	2278	
" 55	90	93	97	100	104	97	90	80	70	60	69	74	1021	
" 60	70	72	73	71	74	72	70	68	70	73	78	83	874	
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14367	

COMMENTS

Average year in pulleys.

Slight increase in machines sold for year.

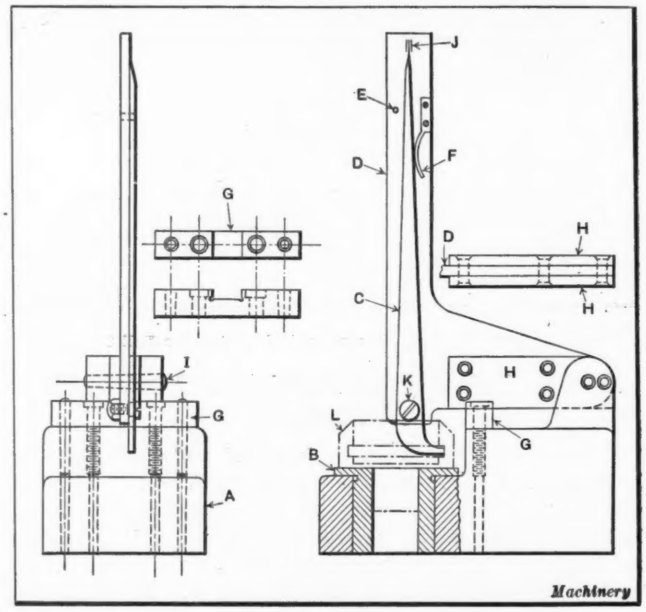
Year Book Page showing how Number of Sales is recorded

every month. A very short space of time is required for the process of analyzing the invoices, and the results of these analyses, as shown in the year book, amply repay any additional expense incurred by the clerical work. The year book also contains an index page as a means of enabling users to find the desired information readily. By making this information available to executives as well as to superintendents and foremen, everybody concerned is informed as to what is expected in the line of future production needs, and greater cooperation is obtained. It is the opportunity for intelligent cooperation that is too often lacking.

Bellows Falls, Vt. S. P. KEATOR

INDICATOR GAGE FOR INTERNAL GROOVES

Gages equipped with micrometer heads which have been employed on quantity production work have been described recently in the columns of MACHINERY, but it is the opinion of the writer that the use of micrometer heads on gages employed on this class of work should be generally avoided.



Indicator Gage which may be used to test Concentricity as well as Depth of Internal Grooves

Mistakes are likely to occur in reading the micrometer, and a great deal more time is consumed in measuring a part with such a gage than would be required if an indicator gage were used. The internal-groove gage shown in the accompanying illustration can be employed, not only for measuring the depth of the groove, but also for testing its concentricity, by merely observing the fluctuations of the indicator as the work is revolved in the locating bushing. The cost of this gage will surely not exceed that of a micrometer-head gage. Repairs will not be required frequently, as there are practically no parts subject to wear except the contact point of the indicator.

The cast-iron base *A* of this gage has two finished parallel surfaces, to one of which the steel bushing *B* is fastened and to the other, the locating block *G*. The bushing *B* is made of machine steel, casehardened and ground, and is a drive fit in base *A*. The shank of the work *L* fits into the hole of this bushing, and its base rests on the head of the bushing. The pieces *D* and *H* are made from ground flat stock (a commercial product) such as used by toolmakers in making gages, test tools, and jigs; this reduces the amount of machining required, as the pieces are simply riveted together after being cut to the required shape and size. The three assembled parts are hinged into a milled slot in the body by means of the tapered pin *I*. Indicator *C* is also made of ground tool steel of a standard thickness and the contact or gaging end only is hardened. The indicator hinges on part *D* by means of screw *K* and may be adjusted by means of a nut. The force exerted by the flat spring *F* when the gage is in use keeps the gaging end of the indicator in contact with the bottom of the internal groove. A stop-pin *E* is provided against which the indicator is forced by the spring when the gage is not in use. Three graduation lines at *J* indicate, respectively, the maximum and minimum limits on the work and the neutral position of the indicator, that is, the zero mark. Block *G*, which is fastened to the body with two screws and two tapered dowel-pins, is employed to hold the device to which the indicator is hinged in a fixed position. To check the accuracy of the gage, a test-piece should be made with a groove similar to that in the work.

Bridgeport, Conn. MAX SLUTZKY

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

Taylor & Fenn Two-spindle Spline Milling Machine. Taylor & Fenn Co., Hartford, Conn. 563
Cincinnati Boring Mills. Cincinnati Planer Co., Oakley, Cincinnati, Ohio 564
Pearson Precision Spacing and Boring Machine. Modern Machinery Exchange, 25 Church St., New York City 565
Edwin Harrington Crankshaft Drill. Edwin Harrington, Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa. 566
Eastern Machine Screw Corporation's Self-opening Die-head. Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven Conn. 567
Taft-Peirce V-blocks and Angle-iron. Taft-Peirce Mfg. Co., Woonsocket, R. I. 567
Worcester Quick-change Lathe. Worcester Lathe Co., 100 Beacon St., Worcester, Mass. 568
Garvin Cam or Form Milling Machine. Garvin Machine Co., Spring and Varick Sts., New York City 568
"Avey" Automatic Drilling Machine. Cincinnati Pulley Machinery Co., Cincinnati, Ohio 569
Springfield Lathes. Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio 570
Ajax Upsetting Forging Machine. Ajax Mfg. Co., Cleveland, Ohio 571
Diamond Surface Grinding Machine. Diamond Machine Co., Providence, R. I. 572
Ferracute Embossing Press. Ferracute Machine Co., Bridgeton, N. J. 572
Barnes Sliding-head Gang Drilling Machine. Barnes Drill Co., 814 Chestnut St., Rockford, Ill. 573
Keller Three-spindle Die-sinking Machine. Keller Mechanical Engraving Co., 74 Washington, St., Brooklyn, N. Y. 573
Reed-Prentice Geared-head Lathe. Reed-Prentice Co., Worcester, Mass. 574
Scully-Jones Keyway Cutter and Chuck. Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill. 574
Milwaukee Horizontal Drilling Machine. Milwaukee Electric Crane & Mfg. Co., Inc., Milwaukee, Wis. 575
"Radbore" Square-hole Drill. Lawson & Co., Inc., 416 W. 33rd St., New York City 576
Morris Radial Drilling Machines. Morris Machine Tool Co., Court and Harriet St., Cincinnati, Ohio. 576
Seneca Falls Gap Lathes. Seneca Falls Mfg. Co., Inc., 381 Fall St., Seneca Falls, N. Y. 577
Fox Multiple-spindle Drilling Machine. Fox Machine Co., Jackson, Mich. 577
Kavle Correct Involute Contour Indicator. Manufacturers' Consulting Engineers, McCarthy Bldg., Syracuse, N. Y. 578
Rose Diamond Holders. S. Rose Co., Inc., 1133 Broadway, New York City 578
"Fulflo" Portable Coolant Circulating Unit. Fulflo Pump Co., Blanchester, Ohio 579
Jones Relieving Attachment. William D. Jones, 1010 Wilder Bldg., Rochester, N. Y. 579
High-speed "Red-E" Lathe and Grinder Center. Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn. 582
Barton Drill Chuck. H. E. Barton Tool Co., 106 S. Jefferson St., Chicago, Ill. 582
Detroit Twist Drill. Detroit Twist Drill Co., Detroit, Mich. 582
Martin Tool-holder. Martin Tool Holder Co., Jackson, Tenn. 582

Taylor & Fenn Two-Spindle Spline Milling Machine

This machine is equipped with two spindles which operate simultaneously for cutting two spline grooves in the same piece, or in separate pieces of work. Its capacity is for splines up to 6 inches in length plus the diameter of the cutters, and the grooves may be cut to any specified depth, or they may be made to meet at the center of the work to form a slot such as the drift slot in a drilling machine spindle. Sufficient capacity is provided for holding work of any diameter up to 5 inches, and of any length.

THE two-spindle spline milling machine here illustrated and described has recently been placed on the market by the Taylor & Fenn Co., Hartford, Conn. It is built from designs developed by the well-known machine tool designer B. M. W. Hanson, and is automatic in operation, being designed to simultaneously machine two spline grooves up to 6 inches in length on opposite sides of the same piece, single splines of the same or different dimensions simultaneously on two pieces, or through slots such as drift pin slots or cutter slots in boring-bars and similar work. Rapidity of action, ease of manipulation, facility of adjustment and large capacity permit this machine to handle a wide range of machine parts. Once set to cut a certain depth and length of slot, it will continue to do so until readjusted. Two cutters operating simultaneously reduce the

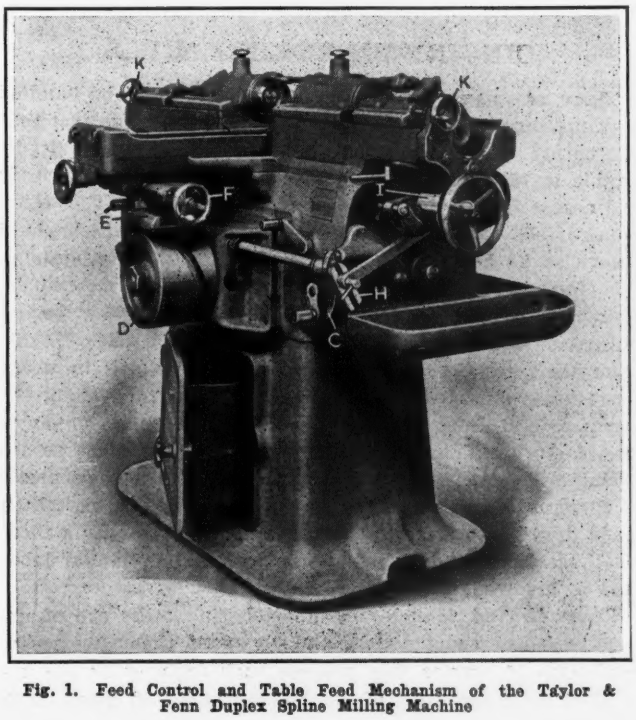


Fig. 1. Feed Control and Table Feed Mechanism of the Taylor & Fenn Duplex Spline Milling Machine

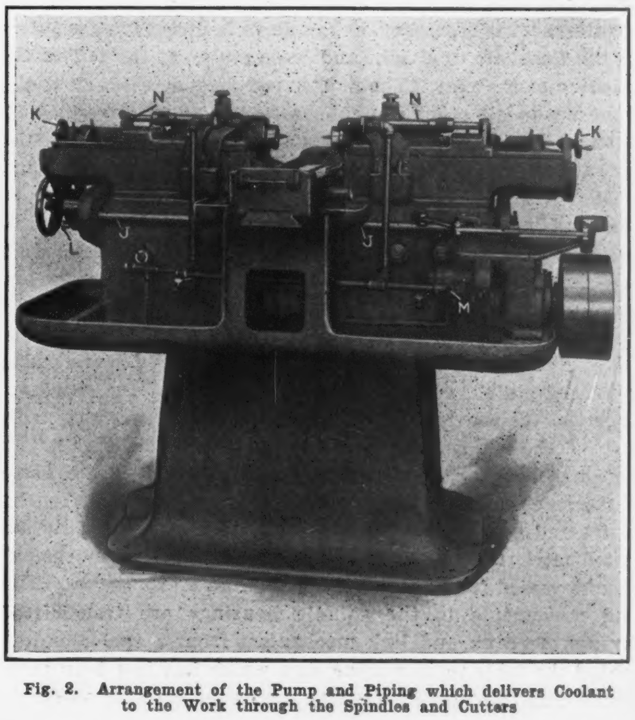


Fig. 2. Arrangement of the Pump and Piping which delivers Coolant to the Work through the Spindles and Cutters

machining time 50 per cent on work where two spline grooves are cut simultaneously in the same piece or in two separate pieces; and work of any diameter up to 5 inches, and of any length may be splined. A V-shaped vise affords a positive clamp for the work beyond the cutter traverse at one end, while the other end of short work, if centered, is supported on a male center and if uncentered is supported in a female cone. Long work is free to project beyond the confines of the machine at both the front and back. The maximum table travel is 6 inches, so that the maximum length of spline which may be cut at a single setting is 6 inches plus the diameter of the cutter. There are six changes of spindle speed ranging from 302 to 1885 revolutions per minute and ten changes of table feed so that an ample range is provided for handling splining operations in various metals and under any manufacturing conditions.

Mechanical Features of the Machine

Efficiency in this type of machine is dependent on the co-ordination of three functions: The cutters must rotate at correct speeds; the traverses of the table between its extremes must be accurate and at the correct rate, and the feeding of the cutters to depth must be properly timed and

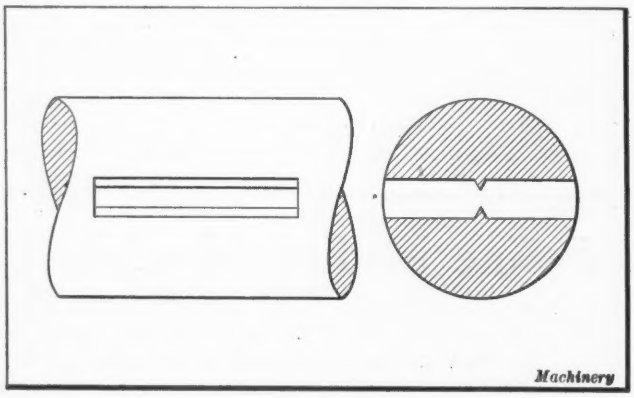


Fig. 3. Diagram showing need of providing Means of removing Fins from the Top and Bottom of Slots which are milled All of the Way through the Work

accomplished by uniform increments. All of these essentials have been incorporated in this machine, with the result that splines of duplicate length and uniform finish and accuracy are produced in a period of time, the duration of which depends upon the length, width, and depth of the spline and the cutting resistance of the metal that is being machined. No countershaft is necessary, as the drive is direct from a pulley on the lineshaft to a tight and loose pulley at the left of the machine at the rear. The shifter rod extends through to the front where all other control levers and wheels are located. A speed-box, within the column and to the left affords the six rates of spindle speed, the controls for these speeds being located within easy reach of the operator while standing at the front of the machine. It is necessary for the machine to be stopped while speeds are being changed, thus affording protection against damaged gearing. The speed gears are made of hardened alloy steel and run in an oil bath. Provision is made for obtaining the ten rates of feed for the table from a gear-box containing a cone of five gears and a two-speed clutch, controlled from the front of the machine. Each one of the ten rates of table feeds is available with each of the six spindle speeds. The work-table obtains its motion through a lever from a cam mounted at the front of the machine under the work-slide. This cam is driven by shafts and gears from the feed-box, and a simple, easily adjusted mechanism is provided, whereby the table movement may be varied from zero to the maximum of six inches. The feed movements to the spindle housings are transmitted through a crank and link mechanism from a cam mounted behind the table reciprocating cam which has just been mentioned, and provides for feeding the cutter into the work.

How the Cutters are Fed into the Work

At each end of the machine there is a small handwheel geared to a feed-nut in such a manner that turning this wheel moves a screw back into the nut. During this process the nut remains in fixed longitudinal position but rotates, while the screw is pressed by a compression spring back into contact with the nut. Turning of the handwheel is continued until a pointer, moving over a graduated scale, assumes a position corresponding to the depth to which it is desired to sink the cutter into the work, and this sets the depth of cut. When the machine is started, the feed mechanism causes the two feed-nuts to rotate, but as they are held against lengthwise movement, the screws push the two opposed cutter-heads inward against the pressure of the compression springs. Feeding of the cutter-heads continues until the predetermined depth is reached at which point the screws run out of the nuts and the feeding of the cutters is stopped. In cases where the slot is milled through, as for instance the drift slot in a drilling machine spindle, it becomes necessary to avoid leaving a small fin in the center of the work. This is accomplished by withdrawing one cutter just before it reaches the center of the work and causing the other cutter to continue its feed movement beyond the center. After the center of the work has been passed by this cutter, the head which carries it recedes. Of course, this synchronized movement of the cutter-heads is performed automatically by power.

Provision for Lubricating the Cutters

In the performance of spline milling operations it is of the greatest importance to provide for the efficient cooling of the cutters and work. Bearing this fact in mind, the cutter lubrication system on this machine has been developed along lines which afford exceptionally efficient results. A reservoir is secured to the door in the column and when this door is opened, the reservoir swings out with it and the supply of cutter lubricant can be readily replenished or the reservoir cleaned. The pump is driven at constant speed from the main driving pulley, thus making the supply of coolant uniform at all times and independent of the speed at which the cutters are driven. From the pump the coolant is carried by a system of telescopic tubes to the hollow cutter-spindles through which it passes to grooves in the shanks of the cutters, from which the fluid is projected under considerable pressure directly on the lips of the cutters, cooling them and at the same time ejecting any chips immediately they are formed.

CINCINNATI BORING MILLS

There are many boring mill jobs which could be handled on a machine of moderate size, were it not for the fact that the nature of the operation to be performed makes it desirable to take exceptionally heavy cuts under high speeds and coarse feeds. Such severe conditions of operation often require jobs to be put on large boring mills, which could otherwise be handled on smaller equipments. Recognizing this fact the Cincinnati Planer Co., Oakley, Cincinnati, Ohio, has recently added to its line of heavy-duty boring mills two machines built in 42- and 48-inch sizes. Aside from their more restricted capacities, these are in every sense heavy-duty boring mills; they are designed along the same general lines as larger machines of this company's manufacture and are especially suited for the more severe boring mill operations which have to be performed on pieces of moderate size. Certain modifications of design have been made in order to increase the convenience of operating these small machines and to reduce the amount of manual labor that is involved.

These 42- and 48-inch Cincinnati boring mills are of unusually heavy construction, and to adapt them for severe conditions of service they possess such features as the use of steel for making all of the driving and feed gears, with

an automatic lubrication system supplying oil to all gears and bearings. In this connection it is important to note that the speed and feed gears do not run in a bath of lubricant. Oil is pumped from a reservoir located between the housings at the back of the machine, and allowed to descend by gravity through tubes leading to each of the gears, bearings, etc., which require oil to assure its efficient operation. This system of oiling is also employed for the table spindle bearings and track. It will be noted from the illustrations that the housings extend right down to the floor and they are bolted, doweled and tongued to the sides of the bed.

The table is driven by a bevel pinion from which the driving shaft extends backward in a horizontal plane. This shaft is carried right through to the back of the machine, so that it may be supported by liberally proportioned bearings. The machine bed and speed-box are cast integral, the gears being located in a compartment at the top of the bed, which also forms a reservoir for oil that is used in the lubricating system; but as has been previously mentioned, the gears do not dip into this oil. For lubricating the gears, oil is allowed to drop on top of them, and after giving the required service it drains back into the reservoir. At the base of the bed, ribs are provided to stiffen the construction. Speed shifting levers and clutch and brake levers are provided in duplicate at opposite sides of the machine, and the links from these levers run through cored openings in the housings. Four geared changes of speed are provided, and with a three-step cone pulley this gives a total of twelve rates of speed covering a range from 2.45 to 59.20 revolutions per minute.

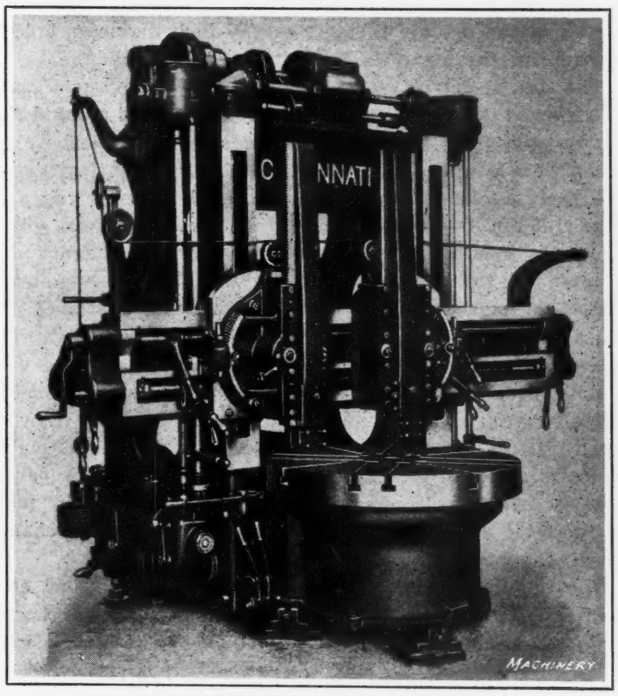


Fig. 1. Boring Mill built in 42- and 48-inch Sizes by the Cincinnati Planer Co.

Each of the heads is furnished with independent feed, the gear-boxes for transmitting these movements to the heads being located at opposite sides of the machine. Eight changes of feed are available, covering a range from 1/40 to ½ inch per revolution. The feed mechanisms are of the tumbler type with the reversing gears in the feed-boxes. The back of the rail is clear of all mechanism. Large friction clutches are furnished for the rapid traverse boxes, and attention is called to the fact that the hand movements, power feeds, and rapid traverse movements are interlocked so that it is impossible for two conflicting mechanisms to be engaged simultaneously. Safety devices, such as automatic trips and shear pins, are provided to protect the mechanism; and micrometer collars are furnished on all the feed-rods. Ratchet handles provide for obtaining fine horizontal and vertical movements of the heads by hand. A self-centering conical bearing supports the table, and all journal bearings in the machine are furnished with bronze bushings. Graduated segments provide for conveniently swiveling the heads to any desired angles up to 45 degrees on either side of the horizontal. If so desired, a turret head can be furnished on these boring mills. The guides on the rail are of the long narrow type and the rail is clamped on both the inside and outside of the housing faces. Danger of damaging the pinions is avoided by cutting the feed racks for the full length of the rams; and a slip friction safety device in the elevating mechanism overcomes the possibility of breakage, in case this mechanism is engaged while the rail is still clamped. Boring mills of this type can be equipped with countershaft drive and a belt shifter. They can also be furnished with a constant-speed motor on the arch in place of the tight and loose pulleys or with a variable-speed motor and single pulley instead of a cone. Of course it will be apparent that in the latter case, the table speeds will be governed by the range of the motor.

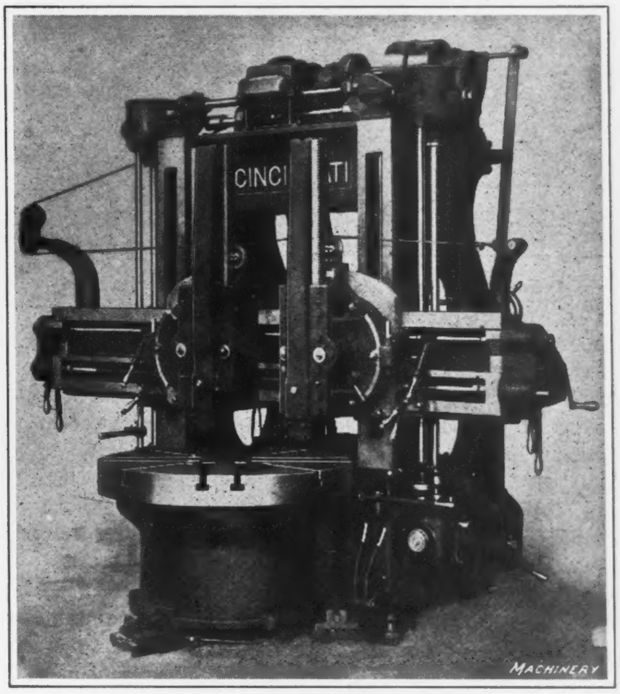
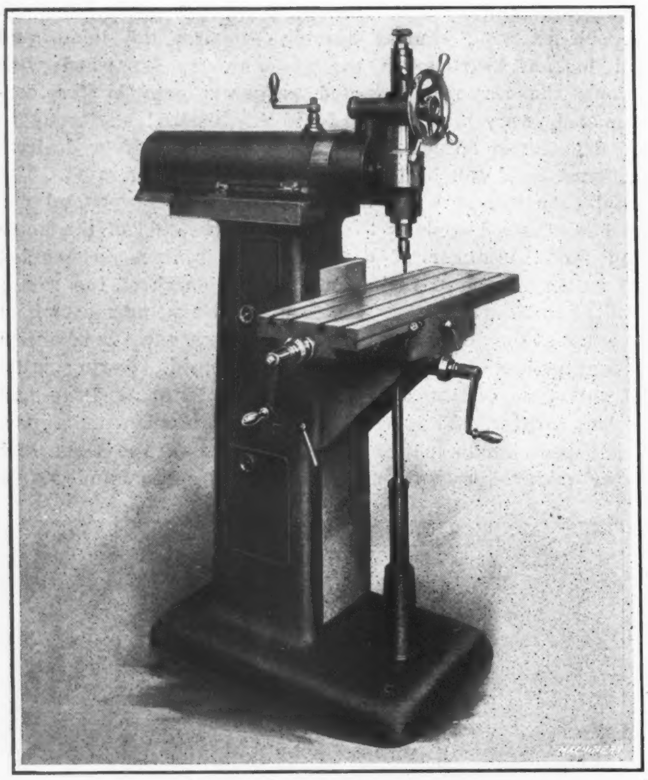


Fig. 2. Opposite Side of the Cincinnati Planer Co.'s Boring Mill shown in Fig. 1

PEARSON PRECISION SPACING AND BORING MACHINE

For use in the performance of accurate jig boring operations and similar work where it is required to have a number of holes accurately bored and spaced in a piece of work, the Modern Machinery Exchange, 25 Church St., New York City, is now building the Pearson precision spacing and boring machine which is here illustrated and described. Reference to the accompanying illustrations will make it apparent that in general appearance this machine has features similar to those found on the knee type of milling machine and on the crank shaper. Located at the right-hand side, there is a cone pulley which provides for obtaining changes of speed, and from this pulley power is transmitted through shafts and gearing to the drilling spindle that is carried by the horizontal ram.

It will be apparent that transverse adjustment of the drilling spindle is accomplished by changing the position of the ram, and longitudinal movement of the work under the spindle by a suitable movement of the table; the vertical movement of the table to bring the work into contact with the



Pearson Precision Spacing and Boring Machine built by the Modern Machinery Exchange

tool is made possible through raising or lowering the knee. In starting to locate for boring a series of holes where an accurate relationship is required between adjacent holes, the method of procedure is as follows: The work is accurately located under the spindle for the first hole and this hole is then bored. At the front of the table and at the left-hand side of the ram it will be seen that there is a fixed stop mounted on the frame of the machine and a micrometer head carried by the movable member. Standard end gages are used in connection with each of these micrometer heads and after one hole has been bored, substitution of suitable end gages in place of those formerly employed enables the cross-movement of the ram and the longitudinal movement of the table to provide for re-engaging the micrometer heads with different lengths of end stops that have been substituted for the ones formerly employed. With an arrangement of this kind the user has absolute assurance that he will secure work possessing the required degree of accuracy; and the rapidity with which holes can be accurately located and bored is the means of effecting a substantial reduction in the cost of performing such toolmaking operations.

EDWIN HARRINGTON CRANKSHAFT DRILLING MACHINE

This machine was designed and built by Edwin Harrington, Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa., to meet the requirements of a motor manufacturer who has several sizes of crankshafts in which oil-holes have to be drilled, requiring flexibility of spindle location and sufficient drilling power to insure high production. Fig. 1 shows the entire machine, and Fig. 2 a single head on the mounting plate. The work holding jig and the crankshaft were loaned by the motor manufacturer. Four individual spindle heads are used, each with its own driving motor and feed control. They are mounted in pairs on plates, which permits of variation of distance between spindle centers, variation of distance between the spindle nose and the work, and change of angle. The length of the spindle feed is sufficient to drill all the way through the average crankshaft, but as two holes usually intersect at the center bearing, and as long drills are objectionable, it is better to divide the cut by drilling successively from two sides. After the holes have been drilled half way from one side, the crankshaft is reversed end for end, which brings it into the proper position to have the holes completed from the other side, meeting those first drilled in the center of the cranks.

The spindle heads are made only for motor drive, to avoid any difficulty of providing for belt drive in various positions. Belted connection is made from the motor to the spindle pulley to allow a flexible drive with the tension taken by ball bearings on the pulley hubs to relieve the spindle from any strain. As only a single-spindle speed is required, the motor can be of the constant speed type for either direct or alternating current, and permanent changes of speed can be made by changing the size of the motor pulley. The spindle runs in a long sleeve, having a bearing for its full length, which is advanced out of the head by its steel rack and pinion for accomplishing the spindle feed. A ball race at the forward end takes the drilling thrust, and a flange attached to the end of the sleeve carries the trip rod. Drilled for the entire length of the spindle there is a 5/16 inch diameter hole to provide for the use of oil-feed drills, if desired.

The feed is driven from the spindle pulley by spur gears, so arranged that the driven gear may be changed to get different rates of feed. Two pairs of triple threaded steel worms and bronze gears, each with a ball thrust mounting, drives the rack pinion. A clutch is provided between the spur gear and the first worm to disengage the power feed, either manually or automatically at any predetermined point; also, a lever on the upper end of the rack pinion operates a clutch for making connection with the worm-gear and provides means for moving the spindle at one handling. The plates upon which the heads are mounted are provided with T-slots to allow movement of the heads to change the distance between centers, and they are located on the table by a central stud with hold-down bolts in slots at the ends. Provision is made for locating a tapered dowel-pin in a separate hole for each size of crankshaft. The location of the plate on the table and the shape of the table are subject to change to suit the job under consideration.

The table is made in a convenient shape to allow easy loading of the work and it has sufficient space to receive a jig of nearly any size. The top has a flat surface with a trough all the way around, and ample ribs are provided to afford the necessary strength. The jig is easily located on the table by an inserted key with hold-down bolts and dowels for endwise location. A tank and two pumps for cutting lubricant make a separate motor-driven unit to be placed on the floor beneath the machine. The end pump (hidden by

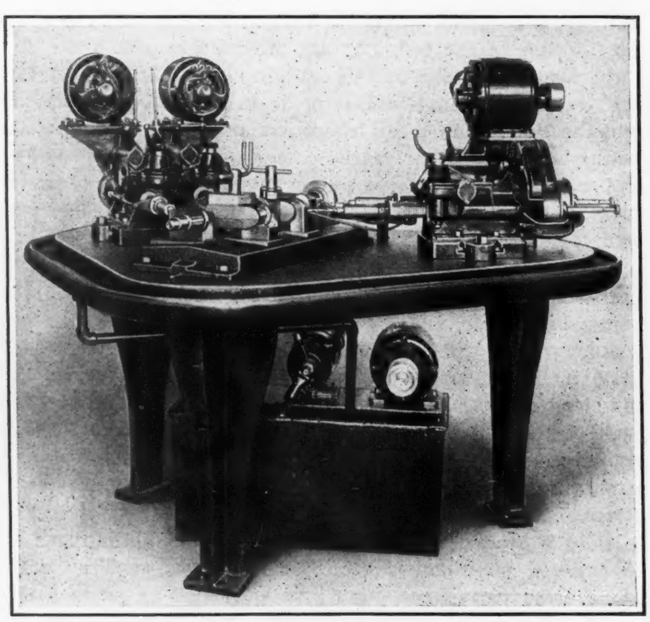


Fig. 1. Machine built by Edwin Harrington, Son & Co., Inc., for Use in drilling Oil-holes in Crankshafts

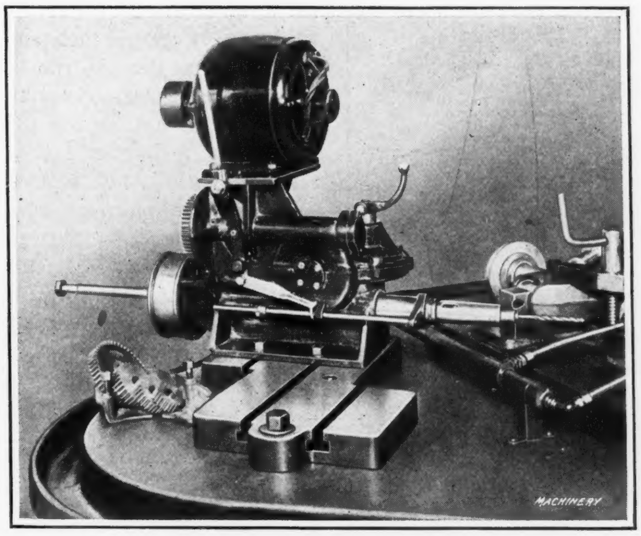
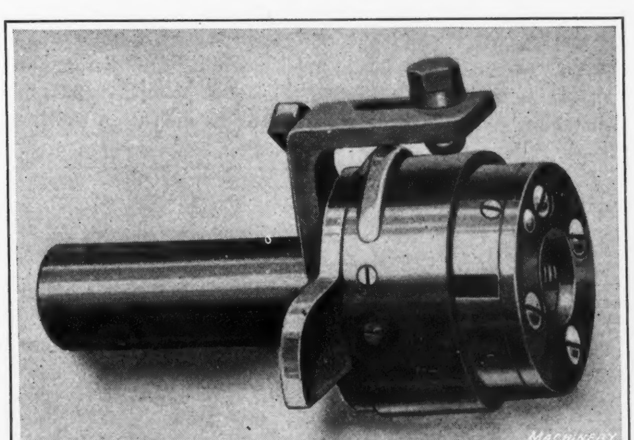


Fig. 2. A Single Head of Machine shown in Fig. 1, illustrating Mounting Plate and Jig

the front leg) delivers oil at the point where the drills enter the bushings, and the pump in the center is provided for a supply through flexible tubes to a fitting on the outer end of each spindle when oil-feed drills are used.

EASTERN MACHINE SCREW CORPORATION'S SELF-OPENING DIE-HEAD

The Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn., has brought out a new self-opening die-head intended for use on Brown & Sharpe automatic screw machines Nos. 00, 0, and 2. It is very small and can be concealed in the hand. This head is installed by fitting the floating shank into a hole in the turret. An adjustable button on the tripping arm which extends along the die-head automatically depresses the tripping device when the thread is cut to the desired length, instantly opening the die-head. Closing is accomplished by a dog which engages the closing handle as the die-head comes up out of the pocket when the turret revolves, setting the chasers ready for the next cut. This new die-head, because it is self-opening, eliminates the time used to reverse and withdraw the ordinary head; does away with the wear on the chasers while backing off; reduces the number of spoiled threads to a minimum; eliminates left-hand tooling; permits the use of a reverse belt in the forward position, providing two forward speeds, one for forming and the other for threading; and also permits the use of higher spindle speeds and dies to match, thus increasing the output and decreasing the need of attention. All parts of the die-head are hardened and ground. A single micrometer screw adjusts the depth of cut, and by changing the chasers, a wide range of threads may be cut with the same head. The ¼ inch size, for example, will cut from ¼—20 to 1/56 or finer. The chasers are hobbed from high-speed tool steel and ample clearance is provided at all points. They are inflexible, being operated by cams, which is said to eliminate tapered threads. This method of holding and operating the chasers is embodied in all H & G die-heads made by the Eastern Machine Screw Corporation, and this new head makes the line quite complete, including as it does, both rotating and stationary types adaptable for use on all kinds of threading machines.



Style D Self-opening Die-head made by Eastern Machine Screw Corporation

TAFT-PEIRCE V-BLOCKS AND ANGLE-IRON

Among the new tools and gages recently placed on the market by the Taft-Peirce Mfg. Co., Woonsocket, R. I., is a line of V-blocks for use in the machine shop. They are made in two styles: the solid type made in a 4-inch size, and the skeleton type made in 6- and 8-inch sizes. These blocks are furnished in pairs, and in each case the vee is central with the sides. The 4-inch size of block is made of tool steel, hardened and ground on all external surfaces, with its sides under-cut in such a way as to permit the use of clamps for holding the blocks in place. The 6- and 8-inch sizes are provided with a slot in one end and in the base, as well as one bolt hole in the base and one in the end, for the purpose of clamping the blocks in place.

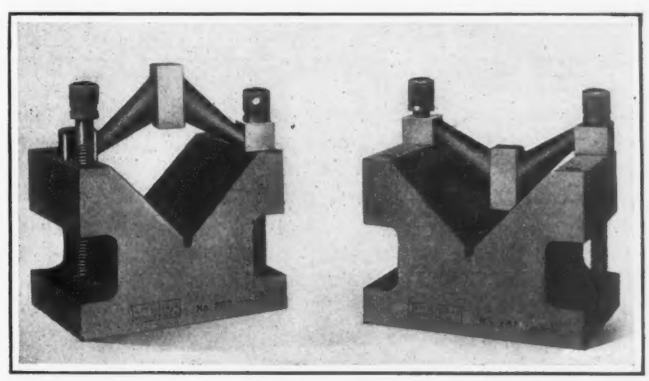


Fig. 1. Solid Type of 4-inch V-block made by Taft-Peirce Mfg. Co.

Both types of blocks are equipped with clamps of novel design. From the illustrations it may be seen that one end of the clamp is open toward the outside; while the other end is open toward the side, which permits the clamp to be swung out from under the screw on one end, and then pulled away from the screw on the other end without turning the screw more than a few turns. The clamps are so designed that they may be used either side up, thus giving a wider range to the size of work that can be held in the block, as well as decreasing the amount of adjustment necessary with the clamping screws. All blocks are equipped with four clamping screws and two clamps. The 6- and 8-inch blocks are made of cast

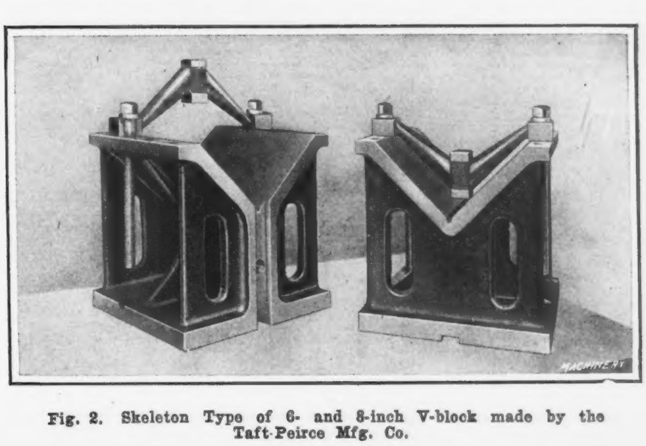


Fig. 2. Skeleton Type of 6- and 8-inch V-block made by the Taft-Peirce Mfg. Co.

iron and so designed as to give maximum strength with minimum weight, as well as to promote convenience in handling.

The angle-iron is one of the most useful tools for setting up certain kinds of work, and it is ordinarily a homemade contrivance. Sometimes holes are provided for bolts, but usually the work is clamped to the legs of the angle with some form of jaw clamp. The Taft-Peirce Mfg. Co. has studied this simple tool and standardized a given design in seven sizes. These slotted angle-irons are specially designed for use on milling machines, planers, boring mills and drilling machines; and a combination of dimensions has been selected to meet as wide a range of conditions as possible, with a minimum number of sizes. Slots are provided clear through both faces—the slots being located at right angles to one another. The webs are cast well back from the edge, and therefore do not interfere with the use of clamps, while the faces are accurately finished so as to be square with each other. In the small sizes, the angles are ground and in the large sizes they are planed.

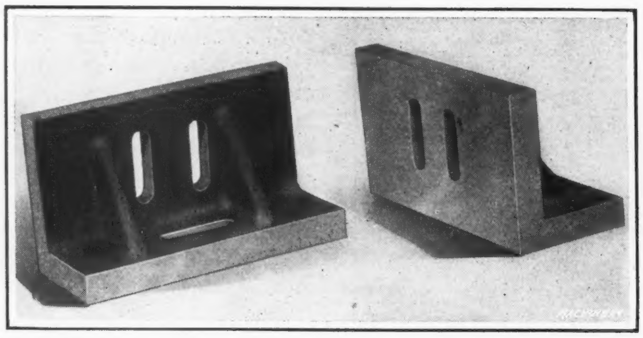


Fig. 3. Angle-iron made by the Taft-Peirce Mfg. Co.

WORCESTER QUICK-CHANGE LATHE

The quick-change feed mechanism on a lathe which has recently been added to the line of machines built by the Worcester Lathe Co., 100 Beacon St., Worcester, Mass., is simple in design and capable of meeting all usual needs, being substantially constructed and of neat appearance and convenient to operate. It provides for obtaining twenty-four changes of threads and feeds without changing gears, the threads being: 4, 4½, 5, 5½, 6, 6½, 7, 7½, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 20, 22, 24, 26, 28, and 30 per inch. Four change-gears are provided, however, namely, a 64-tooth gear for cutting 32, 36, 40, 44, 48, 52, 56, and 60 threads per inch; a 24-tooth gear for cutting 3 threads per inch; a 46-tooth gear for 11½ threads per inch, and a 54-tooth gear for 27 threads per inch.

Changes of gears can be made in one minute or less, as on all Worcester lathes. Gears for cutting other threads, such as: 2, 17, 19, 25, 29, 31, 33, 35, 37, 39, 50, 64, 75, per inch, and other unusual threads, can be furnished on order. Translating gears for cutting the following metric pitches can be furnished: ¾, 1, 1½, 2, 3, 4, 6, and 8 millimeters. Also translating gears for cutting usual threads per centimeter can be supplied. All gears in the quick-change feed-box are of steel, those most subject to wear being heat-treated.

GARVIN CAM OR FORM-MILLING MACHINE

The distinguishing feature of this machine over one previously built by the Garvin Machine Co., Spring and Varick Sts., New York City, for use in cutting flat or cylindrical cams is the change from a vertical to a horizontal spindle, in addition to certain other modifications. Fig. 1 shows this machine arranged for flat cam work, and it will be noted that the work is mounted on the end of the work-arbor, toward the spindle, with the former at the outer end of the arbor. A worm and worm-wheel drive the work-arbor from a universal power-feed shaft which can be seen at the front of the machine. Power is transmitted through spur gearing, giving three changes of feed for the flat cam cutting fixture only. The arm carrying the work-arbor pivots on its forward end, and is guided at the rear end by guides, all mounted on the same table. The arm has in addition to its own weight that of detachable weights to keep the former pin against the former, offsetting the stress of the cutter. These weights can be added to either end of the arm and are made so as to release the pressure on the former when cutting steep angle cams.

Fig. 2 shows the machine arranged for cutting cylindrical cams. In changing the flat cam fixture to the cylindrical fixture, the entire slide shown bolted to the saddle of the machine, can be taken off and laid aside. The power feed universal jointed shaft readily detaches for this purpose and attaches to the cylindrical fixture. In operation the feed

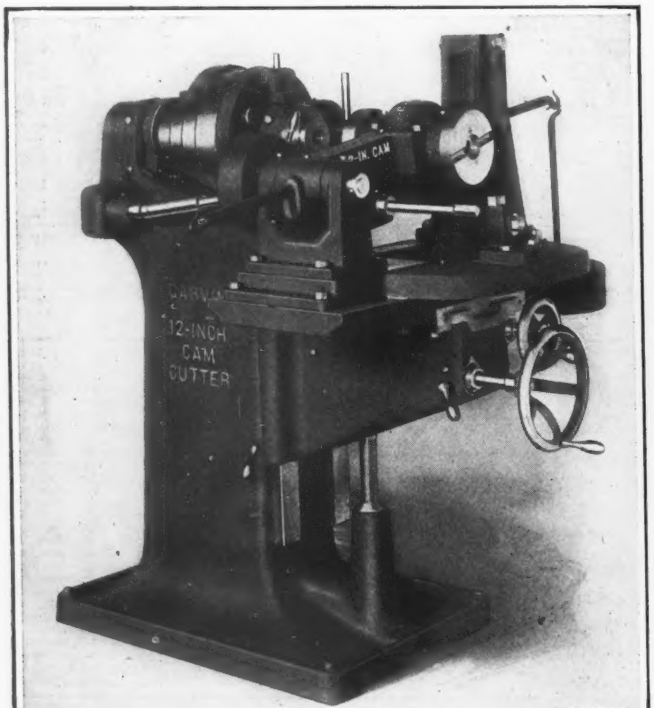


Fig. 1. Garvin Cam Milling Machine equipped for Flat Cam Work

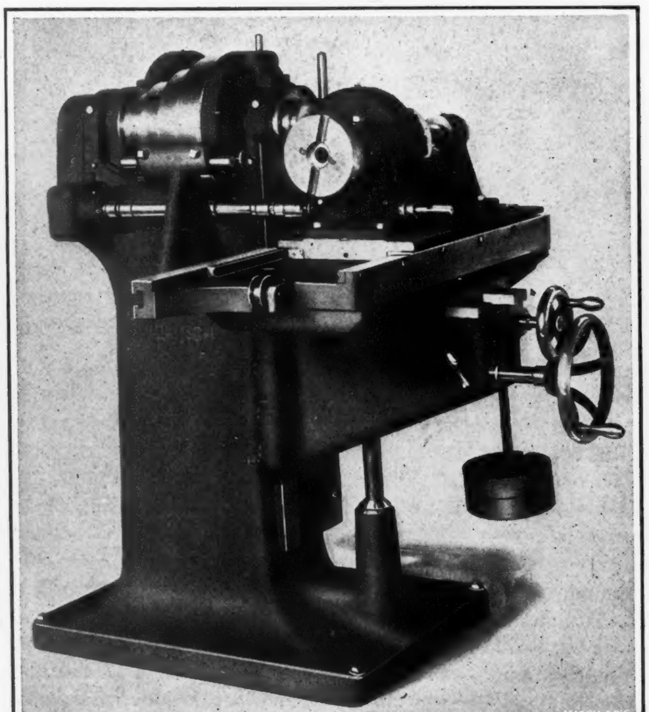


Fig. 2. Garvin Cam Milling Machine equipped for cutting Cylindrical Cams

rotates the work on the arbor, the work being mounted on the far side of the fixture and the former on the other end of the work-arbor. The former pin, shown at the front of the machine is kept against the former by weights. Movement of the cylindrical fixture is very sensitive as it works on large balls in a V-shaped tool steel track. The feed of both attachments can be disconnected by a clutch, giving hand feed control by a wrench. This will be found very handy in setting up for cams that are cored and also for helping over steep angles. The feed of both attachments can be disconnected by a clutch feed control by a crank wrench. On the worm-shaft there is provided a square end to receive a crank. The spindle of this machine is of the Garvin standard milling machine construction, and all gearing is housed, protecting it from damage or injury to the operator. There are two changes of feed provided on the machine when using the fixture for cutting cylindrical cams.

"AVEY" AUTOMATIC DRILLING MACHINE

Readers of MACHINERY who visited the exhibition of the Master Car Builder's Association at Atlantic City, in June of last year, or the meeting of the National Foundrymen's Association at Philadelphia, in October, will recall seeing the machine which is the subject of this article. It is the "Avey" automatic drilling machine manufactured by the Cincinnati Pulley Machinery Co., of Cincinnati, Ohio. The original conception of this machine and the one kept in mind through all the development period was to evolve a mechanism which would reduce manual labor to a minimum. Another point which had always to be kept in view was to produce a standard machine which would be adaptable to a large number of variations in products, thus eliminating to a very great extent the necessity of manufacturers of parts which are drilled in great quantities, having to have special machinery for the operation.

This machine can be used automatically, semi-automatically or as a plain hand feed drill, with equally satisfactory results. No time is required to change from one style to another, as the movement of one member accomplishes this in each instance. When used automatically, both the approach and return of the spindle are automatic, the spindle going through a continuous number of cycles of operations without the necessity of engaging or disengaging the feed by the operator. The strokes can be varied in length from a maximum of 5 inches to a minimum of $\frac{3}{8}$ inch, and the greatest number of strokes per minute is 30. Four rates of feeds and four spindle speeds are available, with a maximum capacity for drilling $\frac{3}{4}$-inch holes in cast iron and $\frac{5}{8}$-inch holes in steel, the maximum spindle speed being 3500 revolutions per minute, which will permit of quite a range in the smaller work.

Provision is made for advancing the spindle by hand ahead of the power feed, without disengaging the latter; and no time is lost when doing this, as the clutches pick up the

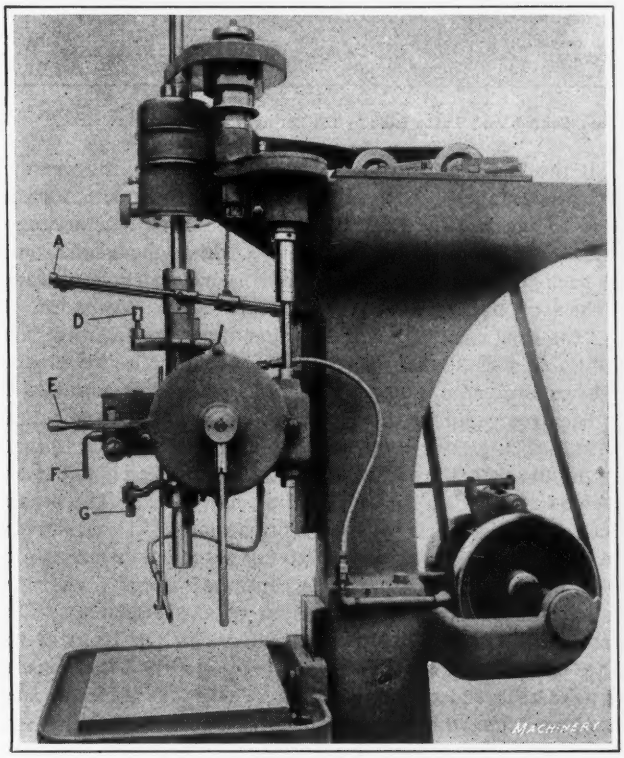


Fig. 1. "Avey" Automatic Drilling Machine built by the Cincinnati Pulley Machinery Co.

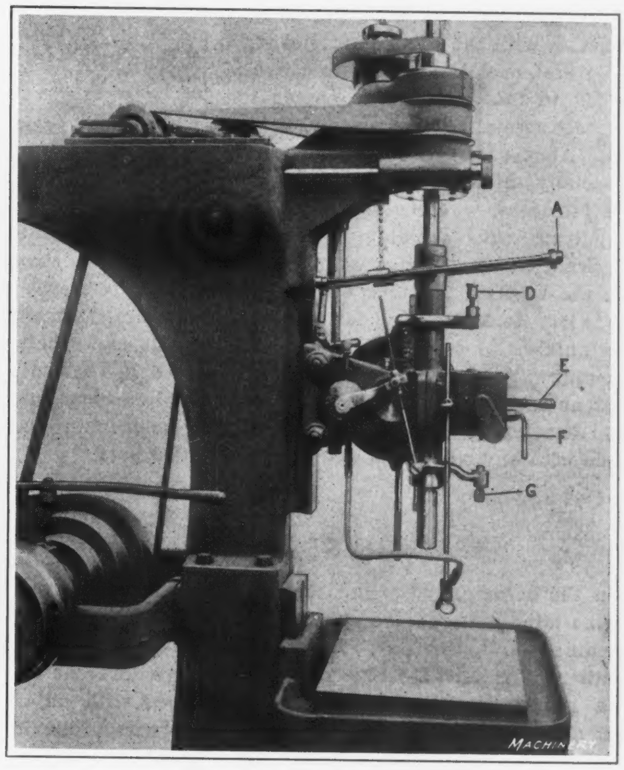


Fig. 2. Opposite Side of the "Avey" Automatic Drilling Machine illustrated in Fig. 1

power feed instantly and automatically, wherever the hand feed drops it. A simple and direct method of securing this result is provided, as extension weight bar *A* directly in front of the operator is used for this purpose. The design and operation of the clutch makes it possible to drill blind holes and to maintain a uniform depth of hole within a limit of variation of 0.001 or 0.002 inch.

A lever for controlling the feed is always within easy reach of the operator. It can be disengaged at any point by means of lever *F*, or, as previously explained, it may be advanced or jumped at will. The amount of over-weight to the spindle can be regulated to accommodate different weights of tools, and all shock of the returning spindle is taken up by means of an adjustable spring plunger. The difference between automatic and semi-automatic feeding is that in the former case, the spindle goes through a continuous number of cycles of operations automatically, as previously explained; while in the latter case it completes one cycle and then stops, one cycle consisting of engaging the feed by means of the clutch lever *E* by hand, the spindle feeding down to depth as determined by the graduated depth stop *D*, tripping automatically, returning to the starting position and stopping. A change from full to semi-automatic feeding is obtained by giving adjustable pin *G* a quarter turn so that the power feed is engaged or not when the spindle returns, as desired. The hand feed lever, used only when the power feed is disengaged, has a ratchet arrangement whereby it can be set

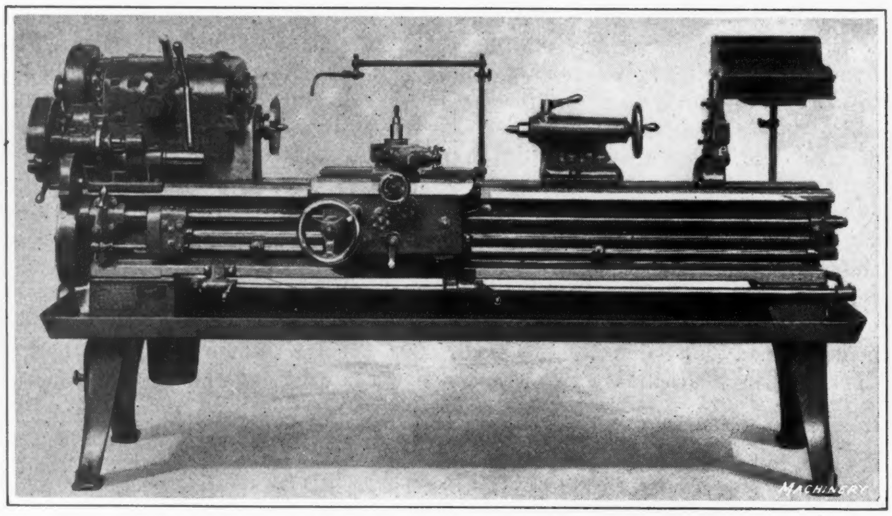


Fig. 1. 14-inch by 8-foot Geared-head Lathe built by the Springfield Machine Tool Co.

at any position in relation to the spindle or can be disengaged and hangs without revolving when automatic feeding is utilized.

All revolving members in the head, as well as the idlers, spindle and countershaft, are mounted on annular ball bearings, making the operation of this machine practically noiseless, very sensitive and avoiding all possibility of sticking through lack of lubrication. The machine lends itself remarkably well to the employment of automatic or semi-automatic fixtures which, in many cases, can be connected to the machine and which function with the spindle movements.

Several useful attachments can be added to this machine to enable it to meet special requirements in drilling. Among these are two which are especially interesting; one is an automatic cut-off valve for the lubricant, whereby the fluid flows only while the drill is cutting, thus avoiding the unpleasant splashing of the lubricant on the operator when loading the fixtures or changing the work. The other attachment to which reference is made is a stroke limiting device which automatically controls the number of strokes that the spindle will make before stopping. The advantage of this will be seen in connection with automatic fixtures when operating on pieces with more than one hole of the same diameter. These machines are made with any number of spindles, from one to six.

SPRINGFIELD LATHES

In the accompanying illustrations there are shown three engine lathes which have recently been added to the line of machines built by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio. Fig. 1 shows the front view of a 14-inch by 8-foot engine lathe equipped with an all-geared head, motor drive, rapid change-gears, relieving attachment, oil-pan and pump, taper attachment, and a cabinet for carrying small tools. Attention is called to the head, which is of the selective geared type, having twelve mechanical changes of speed in the head. It is equipped with ball bearings throughout, with the exception of the spindle journals which are adjustable and oiled by means of sight-feed oilers. The oil passing through these journals is arranged to return to the interior of the head and thus keep up the oil supply of the interior.

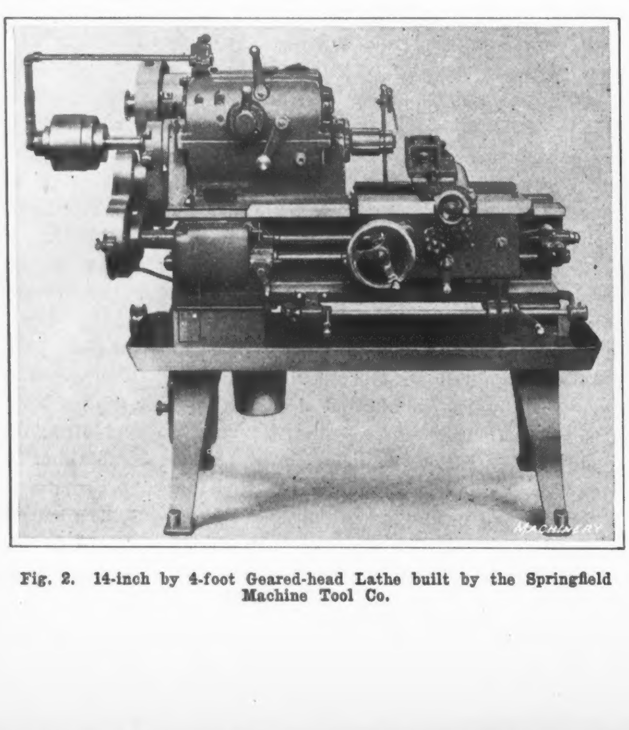


Fig. 2. 14-inch by 4-foot Geared-head Lathe built by the Springfield Machine Tool Co.

All the gears in the headstock are of steel; they run at low speeds and are designed to give a very smooth turning effect to the work. The head shown in Fig. 1 is arranged with two frictions; first, the friction which engages through the back-gear trains and the direct drive gears is operated by the long handle shown in the front of the headstock. It is of the type used in all of Springfield tool-room lathes, and is suitable for all tool-room work, especially in the chasing of threads wherein the operator may perform his operation in the back-gear, and on the returning cut, without disengaging the half-nuts, he can come back at the ratio of about 10 to 1; that is, the returning movement of the carriage is about ten times as fast as the forward cutting movement. The second friction is at the driving pulley of the lathe, in cases where belt drive is used, and in the driving sprocket in the case of motor drives. This sprocket is contained under a guard at the extreme high and left portion of the headstock. The friction is controlled from two positions in the front of the lathe, one traveling with the carriage and the other one at the headstock end of the machine. These levers can be seen extending forward on the lower lateral rod shown on the machine. By means of this friction, the lathe can be instantly started and stopped at any time without stopping the motor. The friction is also provided with a drag so that the work may be quickly brought to a standstill. The headstock is provided with twelve mechanical changes of speed arranged in geometrical progression.

The relieving attachment will cut from two to twenty-six flutes per revolution of the spindle; and it will relieve right- or left-hand threads, both external and internal. The relieving cam is provided with a cone friction in order that the operator may exactly adjust the position of his relief. The rapid change-gear system is capable of cutting forty different threads and furnishing forty different rates of feeds. The upper screw is the lead-screw and is used only for thread chasing. The second rod is the feed-rod, and it is used only for turning; while the third rod is the automatic stop and reverse rod, which controls both the feed and the lead-screw motions. Automatic stop-collars which are adjustable are provided on this lathe. The lever which points directly forward on the right-hand side of the carriage is for the purpose of controlling the right- and left-hand rotation of both lead-screw and feed-rod. This illustration also shows the heavy tailstock which is of recent design; and also the method of bringing the cutting lubricant over the work.

Fig. 2 shows a 14-inch by 4-foot all-geared-head engine lathe of the Springfield "Standard" type. The headstock is of exactly the same design as the one previously described, except that the friction which is interposed in the tool-room lathes between the back-gear and direct gear trains, is now a positive clutch, and is operated by the lever which extends downward on the front of the headstock. The other fric-

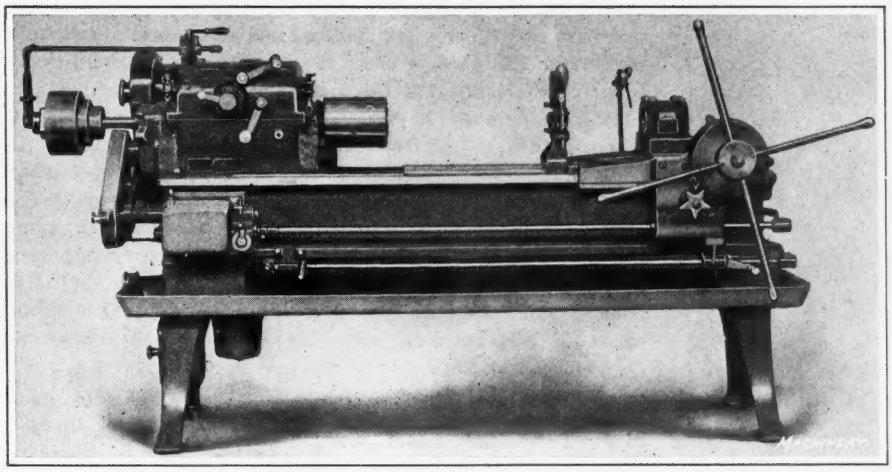


Fig. 3. 14-inch Geared-head Lathe of Simplified Design built by the Springfield Machine Tool Co.

tion, which is the driving friction in the pulley position, is the same in all Springfield geared-head lathes, and it is operated from the front of the bed by the same method as previously described. This machine is equipped with the Springfield standard gear system, which has a simpler method of gearing, in so far that in the production lathes, the change of threads is not important and very seldom used; but an instantaneous feed-box is furnished which gives a wide range of feeds. This lathe is equipped with an air chuck. The particular chuck shown is manufactured by the Logansport Machine Co., Logansport, Ind. The tool-rest on this machine is special and may consist of an adjustable rest which carries a circular threading tool and a small stellite turning tool. The turning tool is adjusted for the diameter of the work and is independent of the threading tool; the function of this particular tool is to turn and thread from the rough, threaded collars by passing over them once.

Fig. 3 shows a 14-inch machine of the geared-head type with the standard Springfield gear system. The lead-screw has been omitted, but the lathe is equipped with the clutch controls as previously described, and an air chuck, this particular chuck being of the collapsible collet type instead of the expanding type. The outstanding features of this machine are the adaptation of the well-known spindle and axle boring carriage to this size of lathe, and the special steadyrest. It consists of a counterbalanced quick-acting, locking mechanism, requiring merely a push of the hand to open it and a pull to close it. These machines are intended purely for use in the boring and reaming of tools at high speed.

AJAX UPSETTING FORGING MACHINE

With the steady increase in the use of alloy and high-carbon steels in the forging industry, a demand has developed for forging machines which will stand up under the increased strain of working these materials and still do their work rapidly and economically. With a view to supplying this demand, the Ajax Mfg. Co., Cleveland, Ohio, has recently offered to the trade an upsetting forging machine embodying features that are new to machinery of this class. This machine has the steel bed reinforced with tie-rods; and it is equipped with sleeve type, phosphor-bronze bushed, crankshaft bearings in the continuous housings of the bed, and steel gears and pinions with teeth cut from the solid blanks. A positive die grip is insured, and protection is afforded against damaging the mechanism by the breaker bolt in the safety knuckle. Operation is by means of the Ajax patented lock device which stops the dies in the wide open position, and the header slide at the back of its stroke. All of these features are well known to those familiar with this company's machines.

The new machine is approximately 40 per cent heavier than the older models, the new 4-inch size weighing 120,000 pounds, the 5-inch, 155,000 pounds, and other sizes in the same proportion. This increase in weight has been utilized to strengthen and increase the size of all parts. Some idea of the capacity of these machines may be had from a test recently conducted at the Ajax plant. A 4-inch machine, in a single blow, forged a disk $9\frac{1}{2}$ inches in diameter and $1\frac{1}{4}$ inches thick on the end of a $3\frac{1}{2}$-inch bar of 0.60 per cent carbon steel at a cherry red heat. In performing this operation the machine gathered 8 inches of stock and flattened it out with no tendency toward stalling.

The slides are of considerably increased length and they are of the suspended type, operating on overhung bronze-faced bearings, which construction places the sliding surfaces in such a position that they receive proper lubrication and are not exposed to undue wear by the accumulation of scale and other abrasive substances. The header slide carries a triple high tool-holder, so constructed as to permit its adjustment to any desirable location of the grooves in the gripping dies. The die-slide carries the moving die in a box-shaped recess, which gives the die the backing of the entire side face of the die-slide against the backing plate during the heading operation. This eliminates local wear in the backing plate and any resulting rocking tendency of the die-slide.

In order to transmit the power necessary for the making of large forgings, a twin gear drive from the pinion-shaft to the crankshaft is employed on all machines of the larger sizes. This gives equal torque to both ends of the crankpin, greatly decreasing the strain in this part. In addition, the crankshafts have been nearly doubled in weight. The self-adjusting safety pitman is an entirely new feature in machinery of this class. Its construction is apparent from Fig. 2. The middle center is slightly raised above the line of the other two, so that a pressure on the ends results in a buckling tendency. This buckling is resisted up to a predetermined pressure by the latch held in place by a heavy coiled spring. When this pressure is reached the latch jumps up, giving complete relief without requiring the building up of additional pressure. On the return stroke, the pitman straightens out, the latch drops into place, and the

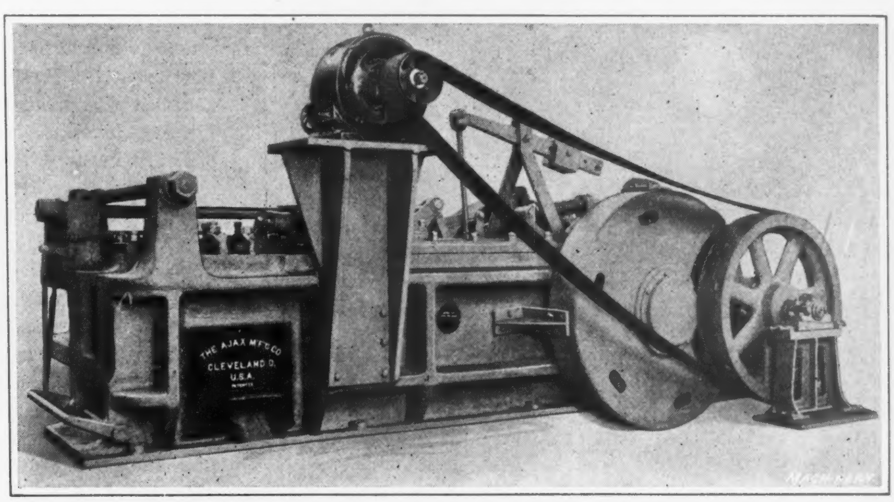


Fig. 1. Improved Type of Upsetting Forging Machine built by the Ajax Mfg. Co.

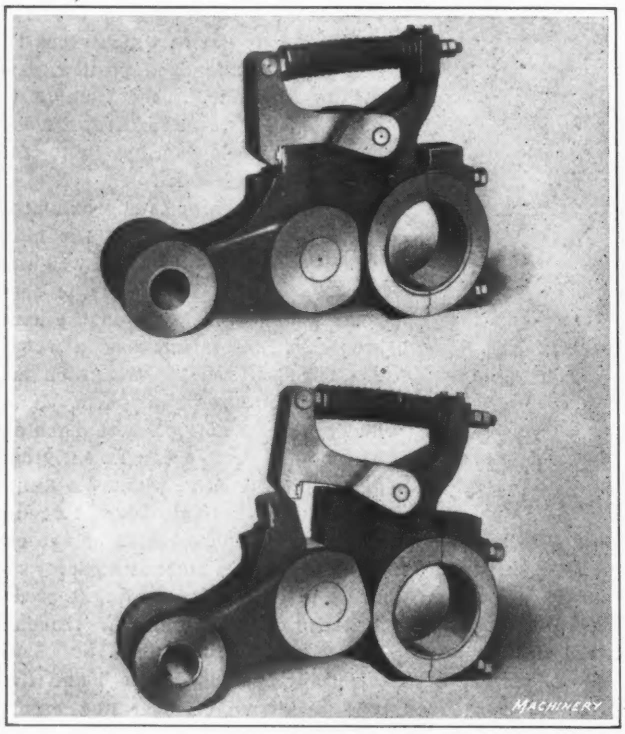


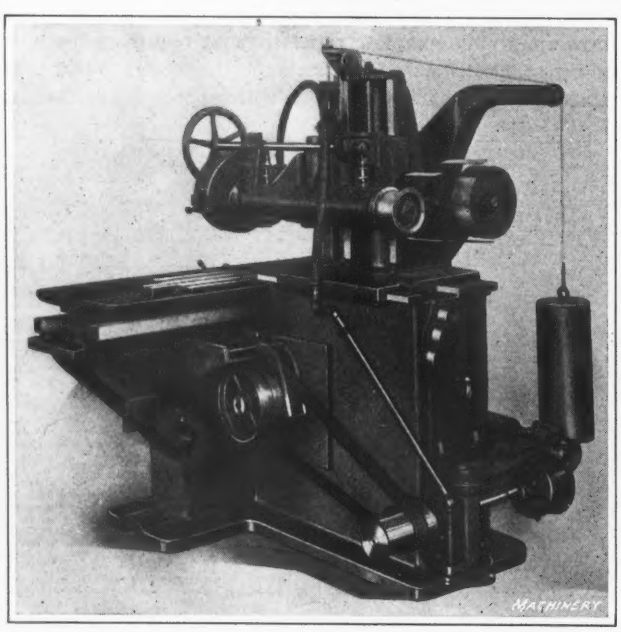
Fig. 2. Self-adjusting Type of Safety Pitman used on the Ajax Forging Machine

machine is then ready to go on with the performance of its work without delay.

By tightening or loosening the spring, a nicety of adjustment can be obtained which permits the working of the machine to its full capacity with assurance that the limit of its strength will not be exceeded. In order to increase the capacity to correspond to the increased power and strength and to fully utilize this additional capacity, the stock gather, die opening and die height have been greatly increased. This makes possible the production of larger forgings in fewer operations than previously, and gives space for the placing of more grooves in a single face of the die, thus reducing the number of die changes that are necessary.

DIAMOND SURFACE GRINDING MACHINE

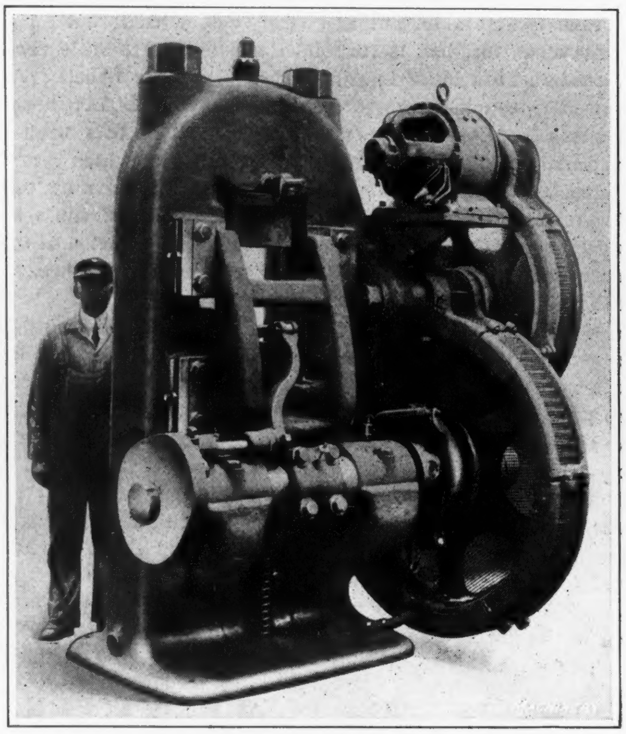
The Diamond Machine Co., Providence, R. I., has recently made some noteworthy improvements in the design of its surface grinding machine. One of these consists of the elimination of one of the electric motors formerly used to supply power to this type of grinder. On the older style of machine, one motor was used to drive the spindle and a second motor to drive the table. In the improved design, which is here illustrated, one motor serves both purposes. It is a 3-horsepower unit and transmits motion to the spindle through a chain and belt drive, and to the table driving mechanism through a chain, worm-gear and belt transmission. The second improvement mentioned is in the method of hanging the saddle counterweight. By using an arm to carry a pulley, the wire cable supporting the counterweight is kept free from contact with any part of the machine which would cause the cable to wear or which would tend to prevent its free movement.



Improved Surface Grinding Machine built by the Diamond Machine Co.

FERRACUTE EMBOSSING PRESS

The toggle action embossing press shown in the accompanying illustration, has been recently built by the Ferracute Machine Co., Bridgeton, N. J. The frame consists of a one-piece casting, with the columns set close together to minimize all possible spring. Each column is 13 inches square and is made solid with the exception of a vertical 5½-inch cored hole containing a 5-inch steel bar, the combined tensile strength of columns and bars allowing for a large safety factor over the 450 tons pressure for which the machine has been designed. The toggles are set in the lower portion of the press and are straightened out by an eccentric shaft at the back. This shaft obtains its motion from the large gear on its outer end, connection being made by a clutch. Pressure on the treadle causes the press to start and make a stroke, automatically stopping when a complete stroke has been accomplished. If continuous action is desired, the treadle may be locked down.



450-ton Embossing Press built by the Ferracute Machine Co.

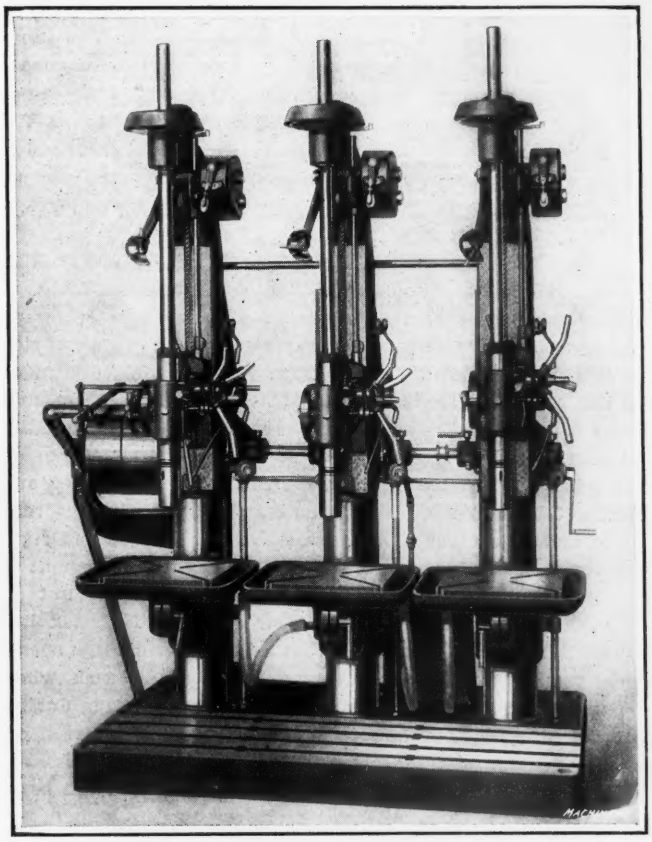
Power is supplied by an electric motor containing a rawhide pinion that gears into teeth cut in the rim of the flywheel. The ram has a stroke of 2 inches, and the distance from head to ram, when the latter is in its lowest position, is 20 inches. A sliding die-chuck is given an intermittent horizontal motion of 10 inches by a series of levers connected to the main shaft by means of a cam. This device enables the chuck, when making its stroke, to dwell while the embossing or coining dies come together. The flywheel, motor pinion, main gear and its pinion are thoroughly guarded,

and wire mesh is cast between the arms of flywheel and gear as an additional safety precaution.

The head is vertically adjusted by means of a horizontally moving wedge, enabling the pressure to be transmitted through solid metal. The weight of the head is taken by a helical spring at the top of the press. Thorough lubrication of the toggles, so essential in presses of this nature, is insured by numerous oil-cups. The press makes thirty-strokes per minute, and the total weight of this machine is about 18,500 pounds.

BARNES SLIDING-HEAD GANG DRILLING MACHINE

In the March, 1919 number of MACHINERY, a description was published of a 26-inch sliding-head drilling machine which had been developed at that time by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill. The accompanying illustration shows a drilling machine of somewhat similar design, which is a recent product of the same firm. This is also a 26-inch machine and has the sliding-head feature; but it will be seen that this machine has independent columns. Eight changes of geared speed and of geared feed are provided for each spindle, all of which are independent of each other, and all under instant control of the operator from the front of the machine. With the driving pulley running at 325 revolutions per minute, the spindle speeds are 230, 183, 146, 93, 57, 46, 36, and 23 revolutions per minute. The available rates of feed are 0.005, 0.008, 0.012, 0.017, 0.022, 0.030, 0.043, and 0.075 inch per revolution.



Sliding-head Gang Drilling Machine built by the Barnes Drill Co.

KELLER THREE-SPINDLE DIE-SINKING MACHINE

In the September, 1915, number of MACHINERY, the article entitled "Mechanical Production of Drop-forging Dies," illustrated and described the use of an automatic profiling machine built by the Keller Mechanical Engraving Co., 74 Washington St., Brooklyn, N. Y., for use in this class of die-sinking. Readers of this publication and other experienced mechanics know that the Keller machine, with which the trade has grown familiar, has been built with one milling spindle and one spindle for rotating a tracer point, with means for guiding it over the surface of a model, in order that the contour of the model may be accurately reproduced in the die-block on which the milling cutter is working. The use of machines of this type has been the means of effecting substantial savings in the cost of a great many different kinds of dies, and during the period of intense industrial activity of the past five years, the possibility of having machines do work which formerly required the services of highly skilled mechanics—of which there was an insufficient supply to meet the demand for their services—was a highly important factor.

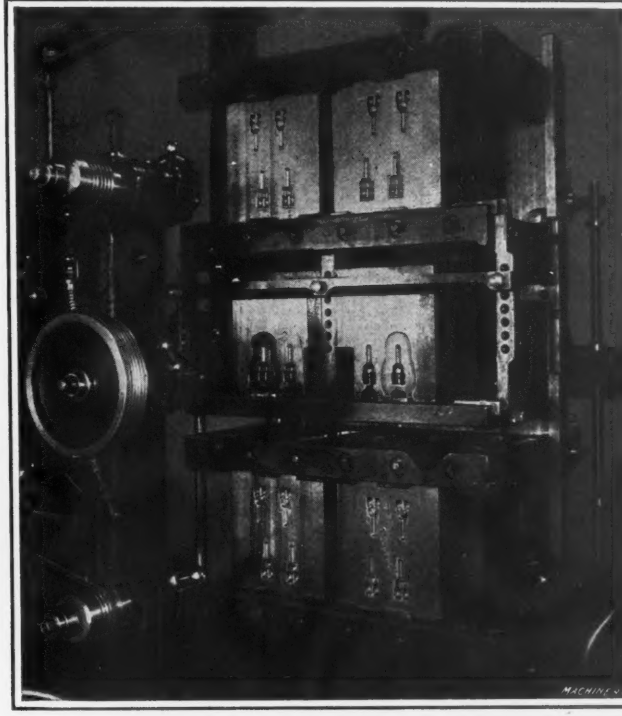


Fig. 1. Three-spindle Automatic Profiling and Die-sinking Machine built by the Keller Mechanical Engraving Co.

Recently the Keller Mechanical Engraving Co., has made a further development in this type of die-sinking machine, which consists of an equipment built with one spindle for guiding a tracer point over the surface of the model, and two

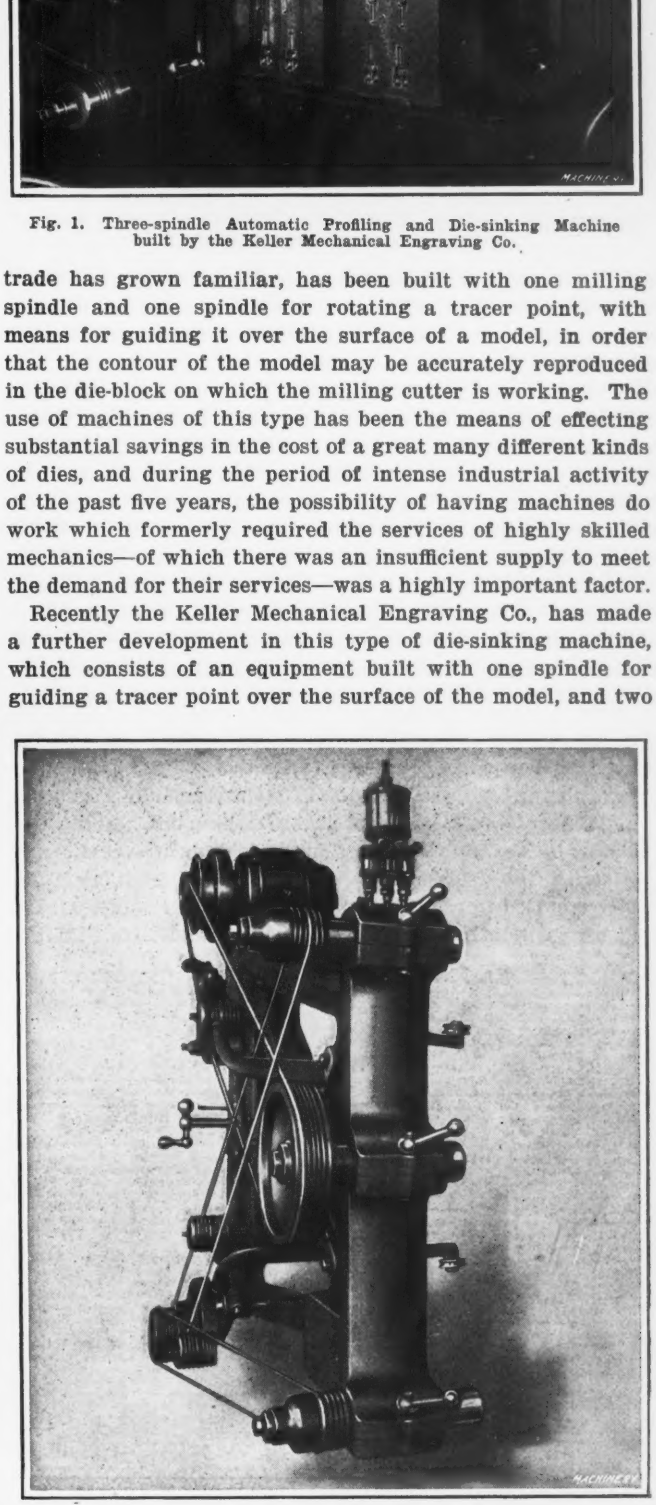


Fig. 2. Three-spindle Arm used on the New Keller Machine

spindles in which suitable milling cutters are mounted to provide for simultaneously sinking two dies which are exact duplicates of the model. A machine of this type is able to effect important savings in production costs in those plants where a sufficient number of duplicate dies are required so that it is a desirable proposition to use a machine for producing them two at a time. On the machine equipped with three spindles, the die-block and model-holding fixture is of essentially the same design and construction as that used on the two-spindle machine, except for the fact that additional means are provided for holding the model between the upper fixed bracket and the lower adjustable bracket. The jacks, clamping bolts, straps and spacers for use in connection with the double-spindle fixtures are also used with the triple outfit. Sufficient capacity is provided for mounting two die-blocks and one model, each 10¼ inches wide by 12 inches deep, and of various lengths from 20 to 28½ inches, according to the conditions of operation. Provision may also be made for mounting four die-blocks and two models, as shown in Fig. 1, and where this practice is followed the capacity is for dies up to 9⅛ inches wide by 12 inches deep, and from 9½ to 12½ inches long, according to the conditions of operation. Of course, it will be apparent that the tracer point is only in contact with one model at a time, and only two dies are being cut simultaneously.

REED-PRENTICE GEARED-HEAD LATHE

The 14-inch geared-head lathe which is here illustrated and described is a recent product of the Reed-Prentice Co., Worcester, Mass. A view of the gearing in the headstock is illustrated in Fig. 2. It is of the selective type, permitting the operator to instantly obtain any one of eight speeds; and changes can be made without slowing down the machine or without removing the cutting tool from the work. It is stated that the point where a change is made from one speed to another cannot be detected on the work, should changes be made while the tool is under cut. The speeds are obtained through spur gears and internal expanding friction clutches, with provision for guarding against the engagement of conflicting ratios of gears, as it is absolutely necessary for the three levers to be in the operative position in order to start the spindle. Consequently, when either lever is brought into neutral position it stops the spindle.

The back-gears are placed in a plane with the spindle and pulley shaft, which makes them readily accessible and permits the bottom of the head to be cast solid, enabling the gears to run in a bath of oil. The intermediate bevel gear in the reversing attachment has also been brought up to a plane with the pulley shaft, thereby making it accessible for adjusting the friction fingers. A locking mechanism has been provided in the form of a plunger that engages a hardened steel notched ring keyed to the spindle, to facilitate

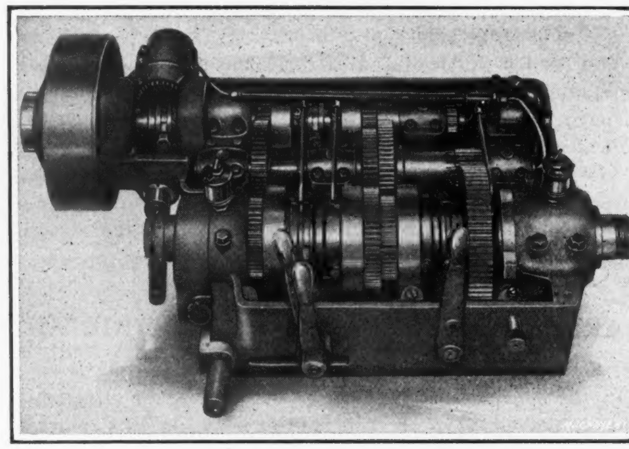


Fig. 2. Gearing in the Head of the Reed-Prentice Lathe shown in Fig. 1

removal of the faceplate. An interlocking mechanism makes it impossible to engage the spindle clutch until this plunger has been released from the spindle, thus safeguarding against accidents. A geared pump in the headstock supplies lubricant for all bearings with the exception of the two main spindle bearings which are supplied from sight-feed oilers. Gurney ball bearings are used in the driving pulley. The rocker carrying the tumbler gears at the end of the head is of new design, consisting of a pull plunger with locating holes in the side of the head. End thrust of the spindle is taken by ball bearings.

A new type of apron has been developed for use on this lathe. It is of the double-plate type, with provision for gaining access to any part of the mechanism without removing the apron from the bed. All shafts and studs are supported at both ends by bronze bearings, and the rear plate is made in box form and securely bolted to the carriage. The front plate is bolted and doweled to the rear plate and may readily be taken off by removing six cap-screws, thereby exposing the gears and other mechanism of the apron. The open and shut nut is planed into the guide cast integral with the rear plate, and a new locking mechanism of very simple and rigid construction has been incorporated to prevent engagement of the longitudinal feed when the open and shut nut is engaged or vice versa. A pull gear engaging the rack has been slightly modified to prevent slipping from the operator's greasy hand. It is disengaged from the rack when screw cutting to prevent the handwheel from rotating during this operation. Both longitudinal and cross feeds are operated by friction clutches. An oil reservoir delivers lubricant to bearings in the rear plate of the apron and the front bearings are lubricated by oilers at each bearing.

A liberal area is furnished for the sliding surfaces of the carriage on the ways. Although the general lines of the tailstock have not been changed from previous designs of the Reed-Prentice Co., the tailstock has been strengthened and additional rigidity provided by giving it a better support on the inside vees or ways of the bed. Two vees support the tailstock. The bed is liberally proportioned with its top made of the drop vee type. All parts of the lathe are interchangeable so that it is a simple matter to order repair parts, should it become necessary to do so after the lathe has been placed in service.

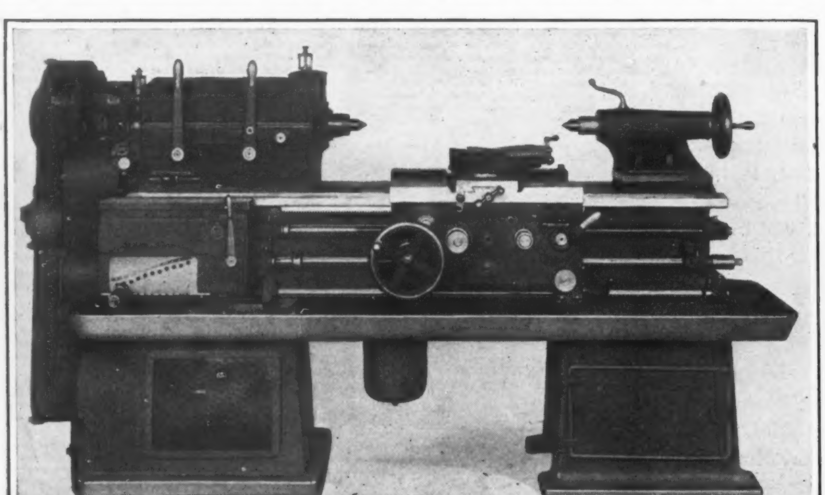
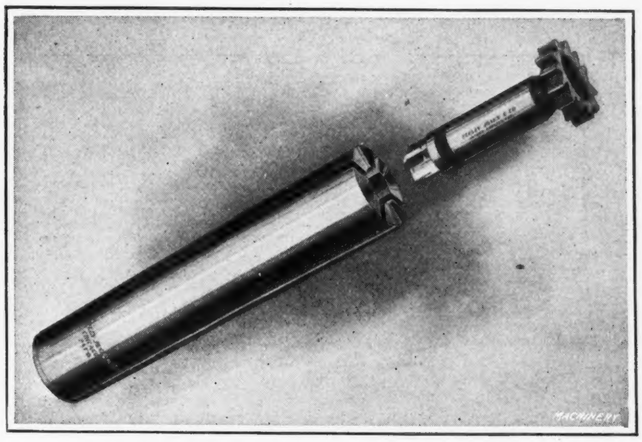


Fig. 1. 14-inch Geared-head Lathe built by the Reed-Prentice Co.

SCULLY-JONES KEYWAY CUTTER AND CHUCK

Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill., have added to their line the "Wear-ever" Woodruff keyway cutter and chuck which forms the subject of the follow-



"Wear-ever" Woodruff Keyway Cutter and Chuck made by Scully-Jones & Co.

ing description. Attention is called to the fact that this chuck has a positive drive and that it is self-centering, thereby preventing all slipping of the cutter and insuring a true center. This chuck fits all makes of milling machines and it will be seen that the only provision needed to use a standard Woodruff keyway cutter is to square the end of the shank. The use of this equipment is claimed to give the two important advantages of a positive drive and a self-centering cutter. The chuck fits all makes of milling machines and is said to reduce the breakage of cutters in addition to giving a high degree of accuracy to the work. In cases where it is necessary to have a considerable distance between the face of the milling machine and the center of the cutter, an extension is provided with the tool to take care of such jobs.

MILWAUKEE HORIZONTAL DRILLING MACHINE

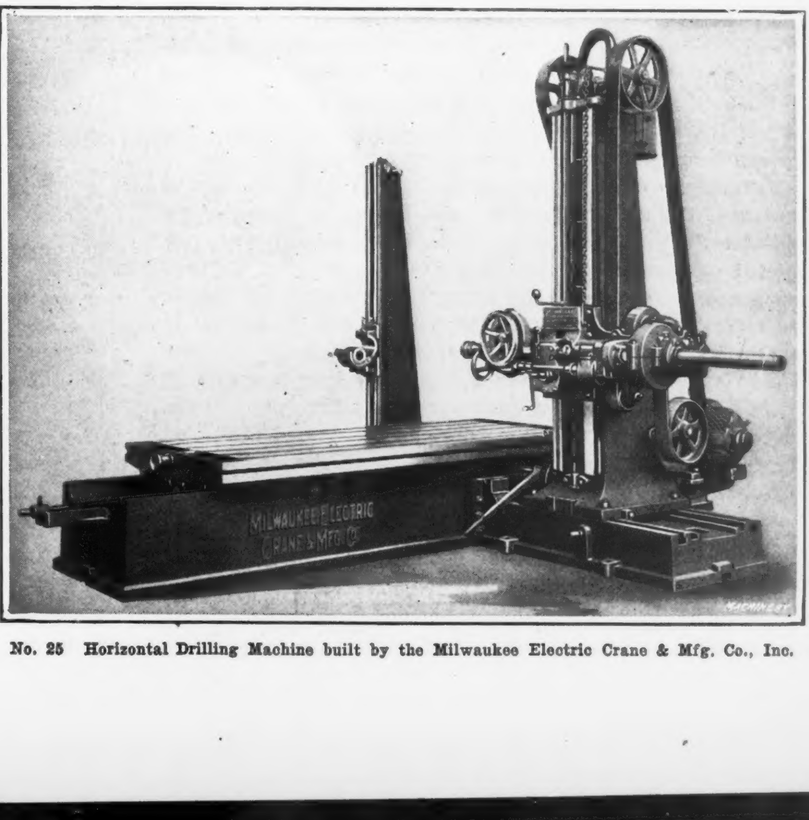
A No. 25 horizontal drilling machine has recently been developed by the Milwaukee Electric Crane & Mfg. Co., Inc., Milwaukee, Wis., which is adapted for performing a wide range of drilling and boring and is especially suited for operating, at one setting, on pieces too long or bulky for the usual type of machine. Double setting of the work not only wastes time but frequently causes errors when boring holes for shafts or bearings which are required to be exactly parallel, as in the case of gear housings for spur or helical gears, the teeth of which must bear evenly along the entire length of face. While originally a homemade tool supplied with a rolling or rail table, in which form it is still made for the rougher kind of work, its range of usefulness was felt to justify a new and modern design and refinement of details to secure greater durability and accuracy in operation, as well as the more rapid change in speed and manipulation made possible by the use of direct-connected variable-speed reversible motors. The ideal drive would be obtained if it were possible, by belting the motor to the spindle with only a single gear reduction, but as this is not feasible, the scheme adopted comes as near to it as possible in the matter of simplicity and directness. This makes for high durability and efficiency by eliminating useless gearing and getting the power of the motor to the spindle by the shortest cut.

The spindle is geared for standard speeds of 20 to 400 revolutions per minute, which may be increased or reduced when special service is to be met. With a 4 to 1 motor speed range and a sixteen-point controller, thirty-two different speeds are obtainable with a single back-gear ratio of about 5 to 1. All gears are of steel, with wide faces and carefully cut teeth; they run in oil and are supported on both sides by large bronze bearings arranged for ample and continuous lubrication. Power is transmitted through a maximum of only four reductions of spur gears to secure minimum boring speed and maximum torque, thus permitting most of the motor power to reach the cutting tool without being reduced to a great extent by friction losses.

The standard spindle feeds provided for this machine are: 0.009, 0.014, 0.020, 0.030, 0.050, and 0.070 inch per revolution. The feed is cut in or out by means of a trip lever and quick return or advance secured by means of the handwheel on the quill-pinion shaft. Gears for obtaining changes of feed are of steel and phosphor-bronze with wide face and heavy pitch, and they run in an oil-tight case for constant lubrication. The quill-drive worm-wheel is made of bronze, and is entirely covered; the worm is made of hard steel, running in oil.

The carriage elevating and lowering mechanism is operated by power or hand, and the driving gear is provided with a limiting torque clutch to secure safety to the mechanism in case the carriage is clamped too hard to the column, when the power drive is thrown into gear. The hand adjustment is used only to secure final setting of the carriage. A steel scale on the face of the column indicates the distance from the top of the table to the center of the spindle, and a corresponding scale is carried by the outboard column. The drill column is mounted on a side extension of the bed and is movable to or from the table to suit the size of the work and reduce the overhang of the spindle. This is an important advantage in many cases where end milling and facing is necessary and secures more accurate spotting of the drill than is possible with a long overhang.

The standard table furnished with this machine is 4 feet wide and 9 feet long and slides on a heavy, planed, cast-iron bed 15 feet long. The table is operated by a screw driven by power and capable of easy and accurate adjustment by hand from both sides of the work. Suitable T-slots are provided for clamping the work or fixtures and the front edge of the table is T-slotted for bolting on special indexing plates or fixtures for accurately locating shaft bearings or other holes in duplicate work. Tables longer or shorter than the standard length can be furnished to meet special requirements. The drill is operated by a 3½ to 5 horsepower, 4 to 1 variable-speed motor, with the starting, stopping and reversing lever placed on the spindle carriage within convenient reach of the operator. This machine occupies a maximum floor space of 14 feet 6 inches by 17 feet 10 inches.



No. 25 Horizontal Drilling Machine built by the Milwaukee Electric Crane & Mfg. Co., Inc.

"RADBORE" SQUARE-HOLE DRILL

For use in drilling a square hole out of any solid material in one operation, without previous preparation and without subsequent finishing, Lawson & Co., Inc., 416 W. 33rd St., New York City, are now making a tool known as the "Radbore Head," for which the Fairbanks Co., Broome and Lafayette Sts., New York City, has the exclusive sales agency. It is a square-hole drilling attachment which can be easily and rapidly attached to any milling or drilling machine. Reference to Fig. 1 will explain just how it is done; and Fig. 2 shows a cross-section of the shank of a drill which is rotated inside of a square guide as shown by the outside lines. If cutting edges are ground on the end of the drill, as indicated at the left-hand side of the illustration and shown in the enlarged view of the drill point at the right, they will sweep across the surface of a square with rounded corners. Hence, if the drill is fed into the material, it will cut out a square hole with filleted corners. To make a hole with sharp corners, one cutting edge is made longer than the rest, and this goes into the corners to square them. In Fig. 2 a Type A drill is shown in the view at the right-hand side and a Type B drill in the view at the left.

Development has made this tool combine the features of simplicity, positive action, and minimum wear. The drills

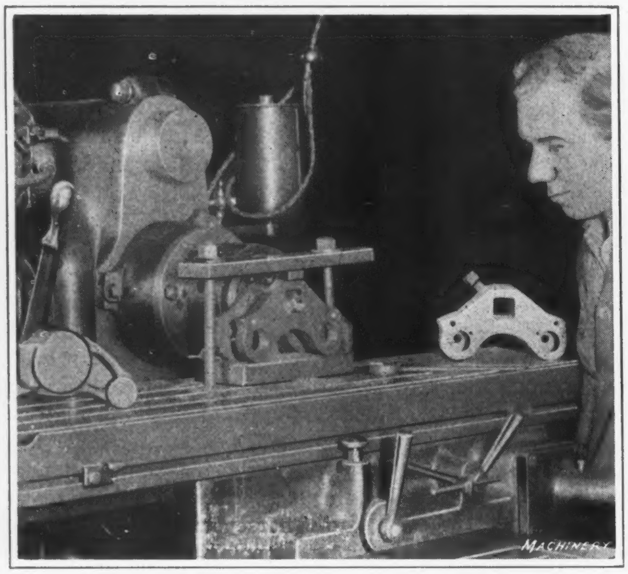


Fig. 1. Application of the "Radbore" Square-hole Drill on a Milling Machine

have a positive drive from the spindle of the machine, and the cutting lips follow a path determined by the adjustable jaws of the head, so that no preliminary round hole is necessary. The cutters are so designed that there is no material in the bottom of the hole, which is not removed by the cutting edges; therefore, blind square holes can be obtained in one operation and without any subsequent finishing.

One of the most important features of this tool is the design of the drills. They are manufactured in two different styles—Types A and B. Type A generates a hole with filleted or rounded corners, this fillet being 1/8 of the drill size; and the radius or the amount of stock that is left in each of the four corners of the square hole, is absolutely equal. This assures uniform distribution of power where a square hole is used, either in a driving gear or in a driving shaft. Furthermore, as a radius is left in the four corners, there is no possibility of the power being applied except on the four sides of the square, owing to the fact that the driving shaft is always milled flat on the edges and hence will not touch in the corners of the square. The measurement across the corners of any square hole drilled by a Type A drill, can be quickly determined by multiplying the drill size by the constant 1.311. The Type B drill is designed for die work, the squaring of the ends of keyways, etc., and the

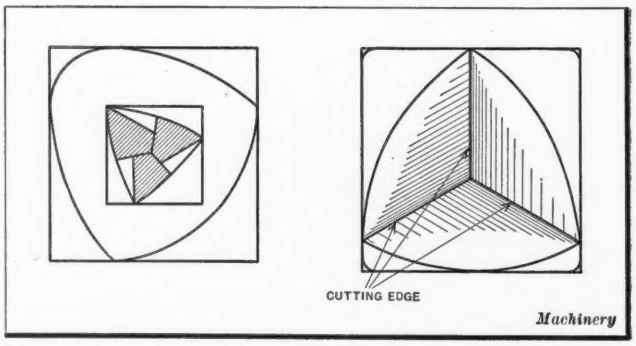


Fig. 2. Types A and B "Radbore" Square-hole Drills

deriving of square holes with sharp corners. In other words, the Type B drill is found useful in the tool-room for the quick and accurate completion of sundry jobs, while the Type A drill finds application out in the factory, where it is used on production work.

"Radbore" heads or chucks are manufactured in four sizes and two different styles—the range of drills from 1/8 inch to 2 inches, being as nearly equally divided between the four chucks as possible. Type A drills are manufactured in sizes ranging from 1/8 inch to 2 inches by intervals of 1/16 inch, and the Type B drills are made in sizes from 1/8 inch to 1 1/4 inches by intervals of 1/16 inch.

MORRIS RADIAL DRILLING MACHINES

In the January, 1917 number of MACHINERY, a description was published of 2 1/2-, 3-, and 3 1/2-foot radial drilling machines built by the Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio. Recently this firm has introduced a machine which is here illustrated and described, radial drilling machines of this type being built in the three sizes that have just been mentioned. Their design is similar to that of the machines previously announced in MACHINERY, except for improvements which have been made in various details of the design. The head is heavily constructed and it is accurately balanced on the arm, permitting it to travel freely, movement of the head being accomplished by a rack and pinion, reduction gears and a handwheel. Helical spindle gears are employed which have a sufficient angle to assure

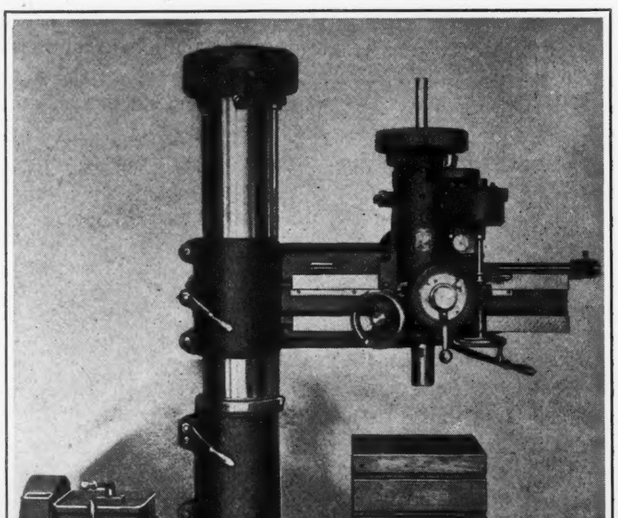


Fig. 1. Radial Drilling Machine built in 2 1/2-, 3- and 3 1/2-foot Sizes by the Morris Machine Tool Co.

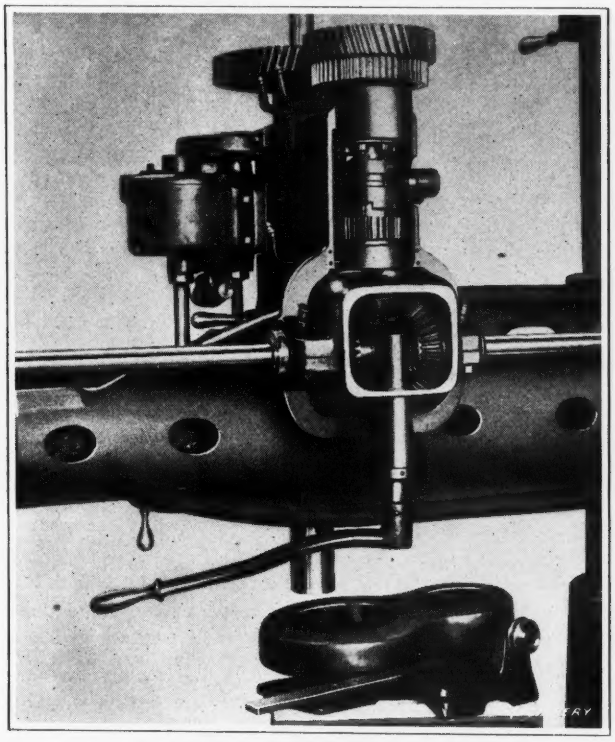
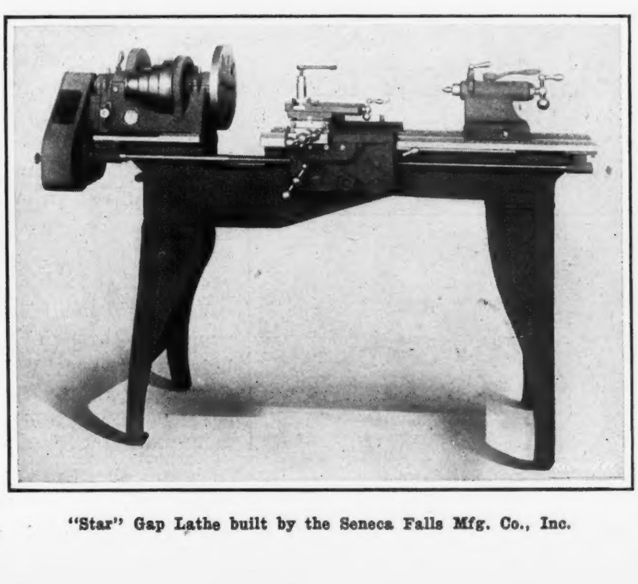


Fig. 2. Rear View of Head on Morris Radial Drilling Machine showing Arrangement of Helical Spindle Gears, Etc.

keeping more than one tooth in mesh at a time, and to avoid end thrust. The column is made of semi-steel and finished to size by grinding. It is supported by both a large ball bearing and roller bearing in the stump, where it is rigidly clamped, this construction permitting the arm to swing with exceptional ease.

SENECA FALLS GAP LATHES

The Seneca Falls Mfg. Co., Inc., 381 Fall St., Seneca Falls, N. Y., has recently developed two sizes of gap lathes which are built to swing 11 and 13 inches, respectively, over the ways and 18 and 21 inches in the gap. In working out the design of these machines the increased swing of the gap type of lathe has been added to the features of this company's "Star" screw-cutting lathes. The bed is made of box section and braced by cross-webs, ample metal being furnished around the gap section. A bridge piece is furnished to close the gap when the extra swing is not required. These lathes are built with beds 5, 6, 7, 8, and 10 feet in length. It will be noticed that the carriage has the cross-slide placed at the left-hand side and the cross-feed screw is furnished with the usual micrometer collar graduated to 0.001 inch. A safety

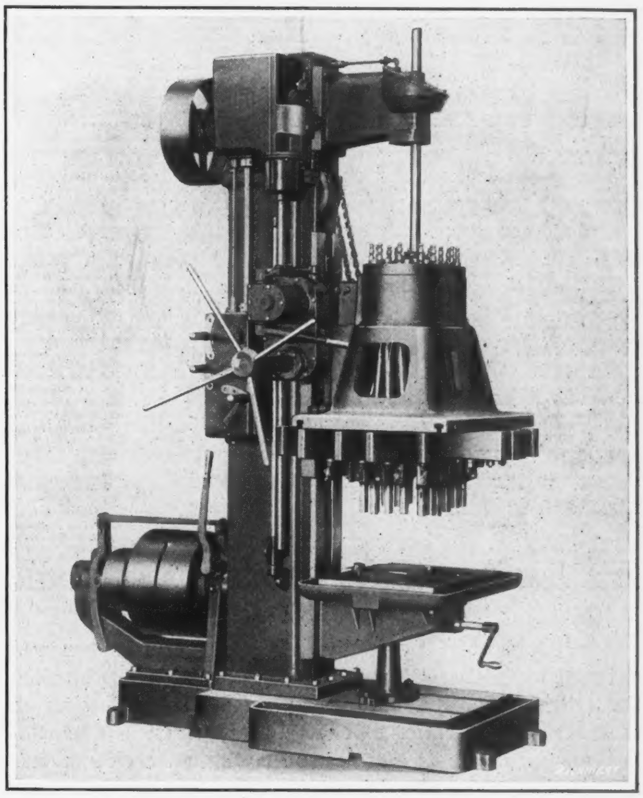


"Star" Gap Lathe built by the Seneca Falls Mfg. Co., Inc.

device is provided in the apron so that the longitudinal feed and split nut cannot be engaged at the same time. All standard threads from 3 to 72 per inch, including the $11\frac{1}{2}$ and 27 pipe threads, can be cut on these machines; and either transposing gears or a metric pitch lead-screw can be furnished to provide for cutting metric threads. Attachments which are available for use in these lathes include a raising block, quick-change gears, taper attachment, individual motor drive, draw-in-chuck, milling and gear-cutting attachments, turret, relieving attachment, etc.

FOX MULTIPLE-SPINDLE DRILLING MACHINE

In the accompanying illustration there is shown a Style D-22 multiple-spindle drilling machine which is a recent product of the Fox Machine Co., Jackson, Mich. This machine is the third in size of a new series which have been developed by this firm. Constant-speed drive is employed, and a disk clutch carried on Hyatt roller bearings transmits power to the head of the machine. The control lever is



No. D-22 Multiple-spindle Drilling Machine built by the Fox Machine Co.

within easy reach of the operator, and the driven pulley which transmits power to the gear-box also runs on a Hyatt roller bearing, being carried on a sleeve with no overhang and no bending strain on the change-gear shaft. The gear-box is mounted at the top of the column and contains two shafts which run on Hyatt bearings, and carry the sliding cone change-gears. The upper shaft, extending into the bevel gear-box, carries the bevel pinion, and the crown gear driving the vertical shaft is carried on a steel sleeve running in a bronze bearing, and the thrust is taken by ball bearings. The sliding cone gears give three changes of speed, these changes being obtained by manipulating the lower lever at the side of the column.

Secured to the side of the speed-box, there is a box carrying the feed gearing. Power is taken from the variable-speed shaft, and transmitted through two sets of cone gears, then through the worm and gear mounted on the vertical shaft. All gears are enclosed and thoroughly lubricated and the control levers are at the side of the column. All thrusts are taken on ball bearings and the head carries the feed-worm

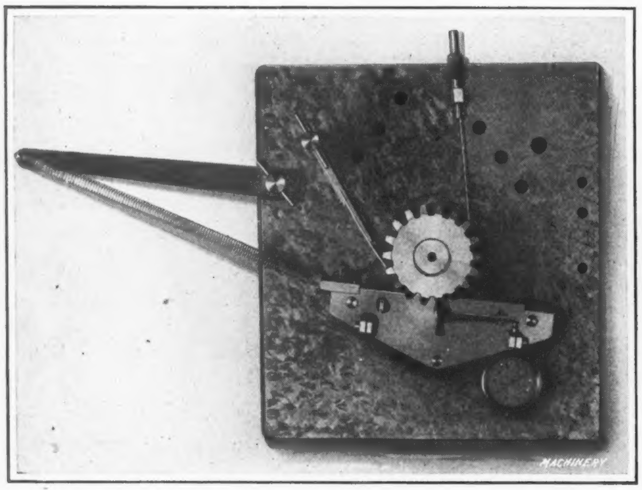


Fig. 1. Kavle Correct Involute Contour Indicator made by the Manufacturers' Consulting Engineers

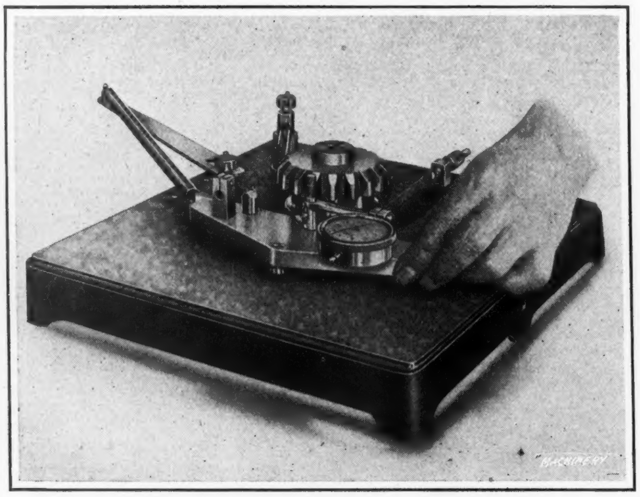


Fig. 2. Using the Kavle Correct Involute Contour Indicator for testing a Gear

and gear which run in oil and are always in mesh. A quick-acting clutch is controlled by a lever at the front of the head and is automatically disengaged by an adjustable stop on the column. On all of the new Fox multiple-spindle drilling machines, the rack is made of extra width and cut from solid steel to mesh with a pinion of special stub tooth design, with a small number of large teeth cut into a solid straight shaft.

The spindles of all Fox drilling machines are turned "over size," for instance, ¾-inch spindles are actually ⅞ inch outside diameter, 1-inch spindles 1⅛ inches outside diameters, etc. All spindles ½ inch and over are carried in cast-iron bearings with bronze bushings. The bearings are securely held to the adjusting arm by two bolts which lock them in place. There are two spindle gears to provide different speeds for each spindle, which make it possible to use different sizes of twist drills and drive each at the correct cutting speed. Some users of multiple drilling machines prefer the single speed drive to the spindles, and for such users, the Fox Machine Co. builds machines with a single-speed drive.

KAVLE CORRECT INVOLUTE CONTOUR INDICATOR

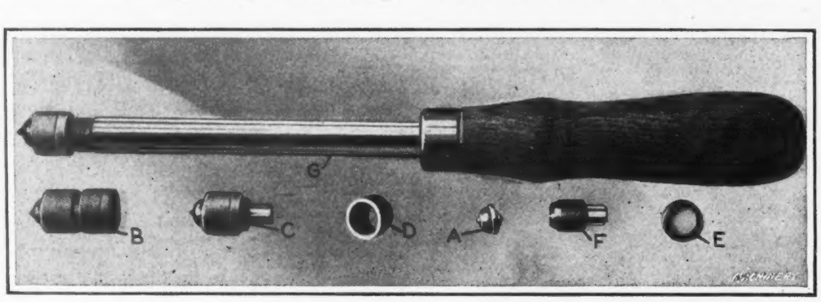
The Kavle correct involute contour indicator has been developed by the Manufacturers' Consulting Engineers, McCarthy Bldg., Syracuse, N. Y., for use in testing the accuracy of the form of gear teeth. Its operation is based on the same principle as that used in laying out a true involute tooth form. The indicator consists of a baseplate, a plug of the same diameter as the base circle of the gear to be indicated, a plug or bushing to locate the gear, and a straightedge which is held in contact with the base circle plug by means of a steel ribbon, 0.002 inch in thickness, and a spring. On the straightedge there is mounted a 5 to 1 lever, the short arm of which is in contact with the tooth form to be indicated, while the long arm is in contact with the plunger of an Ames indicator. This 5 to 1 lever multiplies the reading, so that one mark on the indicator gives you a reading of 0.0002 inch. As the straightedge is rolled about the base circle plug, the short arm follows the tooth form while the long arm remains in contact with the indicator plunger. If the tooth is of true form the pointer will not move; but if the tooth is not of true form, the indicator will show any deviation from true form to 0.0002 inch. The indexing of the teeth may be indicated to the same degree of accuracy by means of the spring stop together with the Ames indicator reading.

ROSE DIAMOND HOLDERS

In the accompanying illustration there is shown an adjustable diamond holder which is sold by the S. Rose Co., Inc., 1133 Broadway, New York City. The stones are set in metal by a cold process, and under high pressure the metal solidifies and is then completely steel jacketed. The metal used for this purpose has a melting point of 1217 degrees F., so that the rubbing of the wheel against the diamond cannot create enough heat by friction to injure the matrix in which the stone is held. This method surrounds the diamond with a metal matrix that closely embraces the stone and supports it at all points except the actual edge that is to be used. It is claimed that the cold process of setting eliminates danger of checking the stone and that there is no danger of the heat causing loss of weight or impairing the hardness of the diamond.

Reference to the accompanying illustration will make it apparent that the diamond set in its metal mounting is carried in a holder which is secured to the threaded end of a shank. At *A* there is shown the diamond set in its metal mounting and *B* illustrates the diamond mounted in a holder to fit the wheel truing device on a Norton grinder, while the mounting to fit the wheel truing device on a Landis grinder is shown at *C*. At *A* it will be seen that the diamond point is located at the left, and a conical seat at the right of the mounting fits into a concave conical seat machined in the end of the shank. Behind the cap *D* there is a collar or washer *E* that is screwed up behind the threaded cap to serve as a lock-nut to prevent the collar from turning on its thread. At the top of the illustration there is shown a diamond holder with a long shank that has a wooden handle to adapt it for use by hand.

All of these holders can be used for any size stone from ¼ to 2½ carats. In setting a diamond in the holder it is placed in position in the inner collar with the point projecting through the hole, and the metal is then forced into the space between the diamond and the collar, thus affording the uniform support on all sides of the diamond to



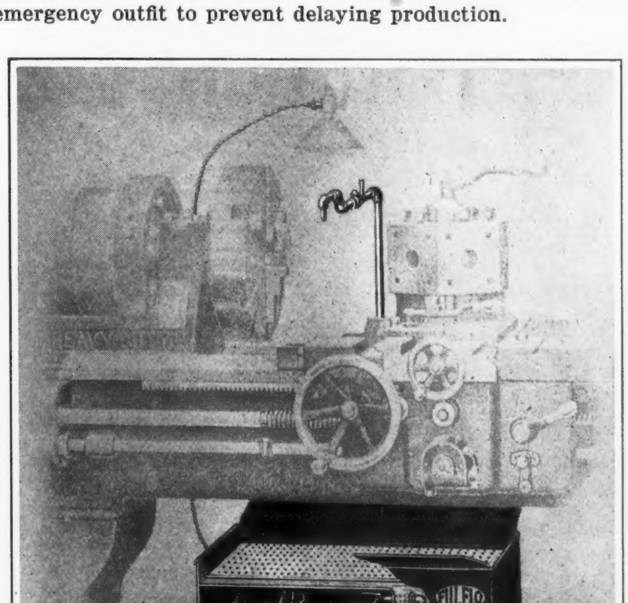
Diamond Holders made by the S. Rose Co., Inc., for Use in the Wheel Truing Device on Norton or Landis Grinders, or for Operation by Hand

which reference has been made. Mounted in this way, and clamped by the method previously described, it is claimed by the manufacturer of this tool that the final result is just as solid as if the tool were made in a single piece.

"FULFLO" PORTABLE COOLANT CIRCULATING UNIT

The accompanying illustration shows the general design and one of the applications of a portable motor-drive pump unit, made by the Fulflo Pump Co., Blanchester, Ohio, for delivering coolant to the cutting tools and work on all sizes and kinds of machine tools. This portable unit was designed to provide a compact and inexpensive cutting tool lubrication system that could be quickly wheeled up to any machine tool in the shop, and immediately start supplying the coolant to the cutting tool. A great many machines in the shop are not equipped with a pan and pump because they are used mostly for working on gray iron; but occasionally such machines are used on malleable iron, steel or some other hard materials where coolant is vitally necessary to attain the best results. It is for such occasions that this portable unit is needed, for while it is possible to work such materials dry after a fashion, it is certainly not economical to try to do so, since much more work and better work can be done with coolant.

There are other cases where it has become necessary to use machines, not equipped with a pan or pump, most or all of the time on materials requiring coolant. It is difficult and expensive to try to improvise a coolant system for such machines, and the "Fulflo" portable unit is a satisfactory as well as an inexpensive solution as a permanent system for such machines. On machines having individual coolant systems, but for some reason the pumps or other parts of the system are out of commission, the portable unit affords an emergency outfit to prevent delaying production.

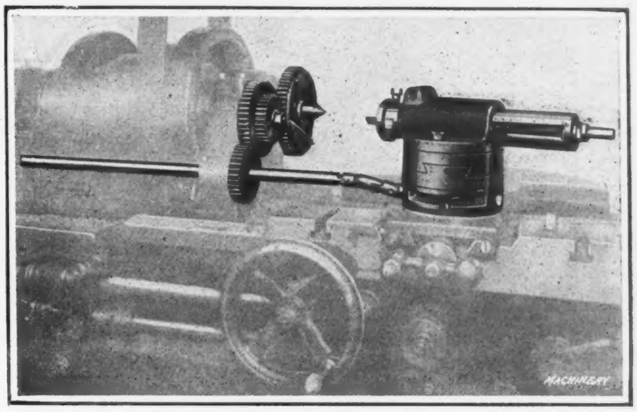


Portable Unit made by the Fulflo Pump Co., for circulating Coolant to Cutting Tools

It is a complete, self-contained system, requiring nothing but the attaching of the motor cord to a lamp socket. The total height from the floor is only 14 inches which permits of its being rolled under almost any lathe. Provision is made for attaching additional splash boards when required. The pump and motor are completely covered, affording them ample protection from both liquid and dust. This outfit can be used on grinding machines, as well as on lathes, drilling, gear-cutting, and milling machines, etc., as the pump is not affected by emery dust or grit and chips. The same pump, motor, and base may be installed on a machine as a permanent installation, where the portable outfit is not required, since the machine is provided with its own drainage and pan system.

JONES RELIEVING ATTACHMENT

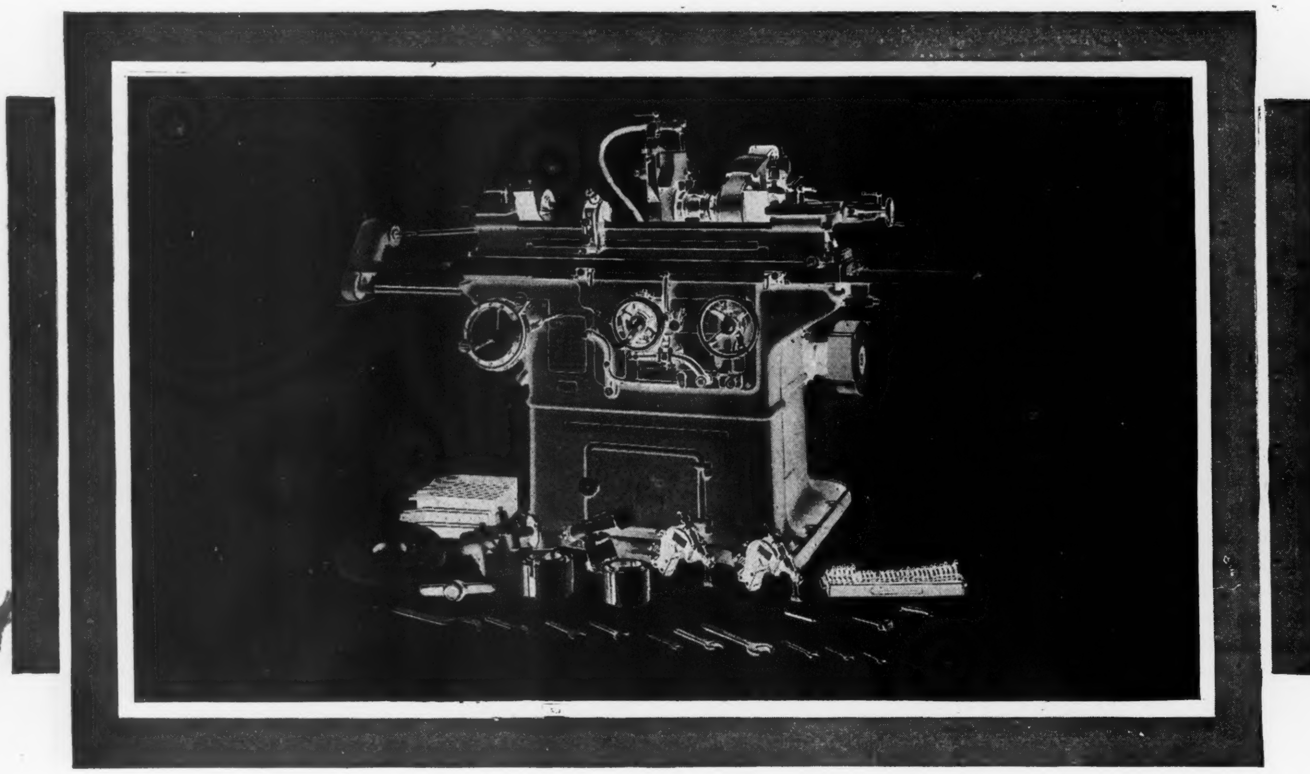
In the accompanying illustration is shown a device known as a full-swing relieving attachment which was designed by Harold R. Cleveland, and is manufactured by William D. Jones, 1010 Wilder Bldg., Rochester, N. Y. This tool is adapted for heavy work, and it has been designed to provide for the performance of all relieving operations including any angle, side, face or irregular spaced flutings or taper cutting. It is



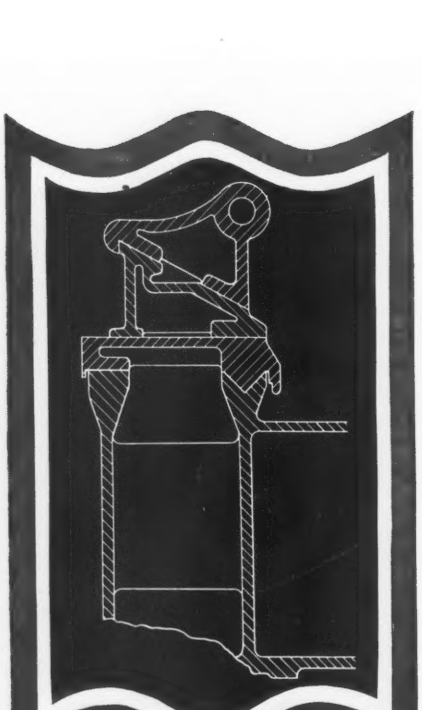
Full-swing Relieving Attachment made by William D. Jones

made in three horizontal sections, two of which remain stationary after they have been brought into alignment. Graduations provide for setting to any required angle, and the tool-holder can be moved for any axis of movement without reference to the tool. This relieving attachment can be used on any type of lathe which has a compound rest and it is usually made for 13-, 16-, and 18-inch lathes, while special attachments may be furnished for use on 24- and 30-inch lathes. The relieving head is mounted on a swivel base in place of the compound rest, and is driven from the nose of the headstock by a gear, from which power is transmitted through a train of change-gears to provide for relieving various numbers of flutings. A gear rack for the change-gears is mounted on the bed of the lathe immediately beneath the driving gear. A universal joint between the splined shaft and relieving head provides for movement of the cross-slide, and attention is called to the fact that the entire mechanism is direct geared or stationary with the exception of the reciprocating tool-holder.

A hand cross-feed movement of 3 inches is provided on the tool-holder for cross-relieving either straight or on an angle; and provision is made for vertical adjustment of the tool bit over a range of 3/8 inch. The tool-holder is designed for bits up to 5/8 inch square. This attachment may be used in connection with the taper attachment of a lathe to provide for relieving conical shaped cutters, pipe reamers, etc. It will also relieve form contour cutters when used in connection with a form and weight to guide the carriage. The standard relief is 0.1 inch, but special cams can be provided to produce a greater or lesser relief than the standard amount. A set of four cams with one, two, three and four steps is furnished with each attachment to provide for operating on cutters with various flutings, it being necessary to use a suitable cam in connection with the proper change-gears. It is possible to relieve cutters with from 2 to 28 flutes, with the exception of those numbers that are not used such as eleven, thirteen, seventeen and twenty-three. Spiral driving gears are employed, and the cams are made of heat-treated nickel steel. All operating surfaces are ground and scraped, and provision has been made for adequate lubrication.



Let Brown & Sharpe Maintain Your



These machines embody features that are facts and not possibilities.

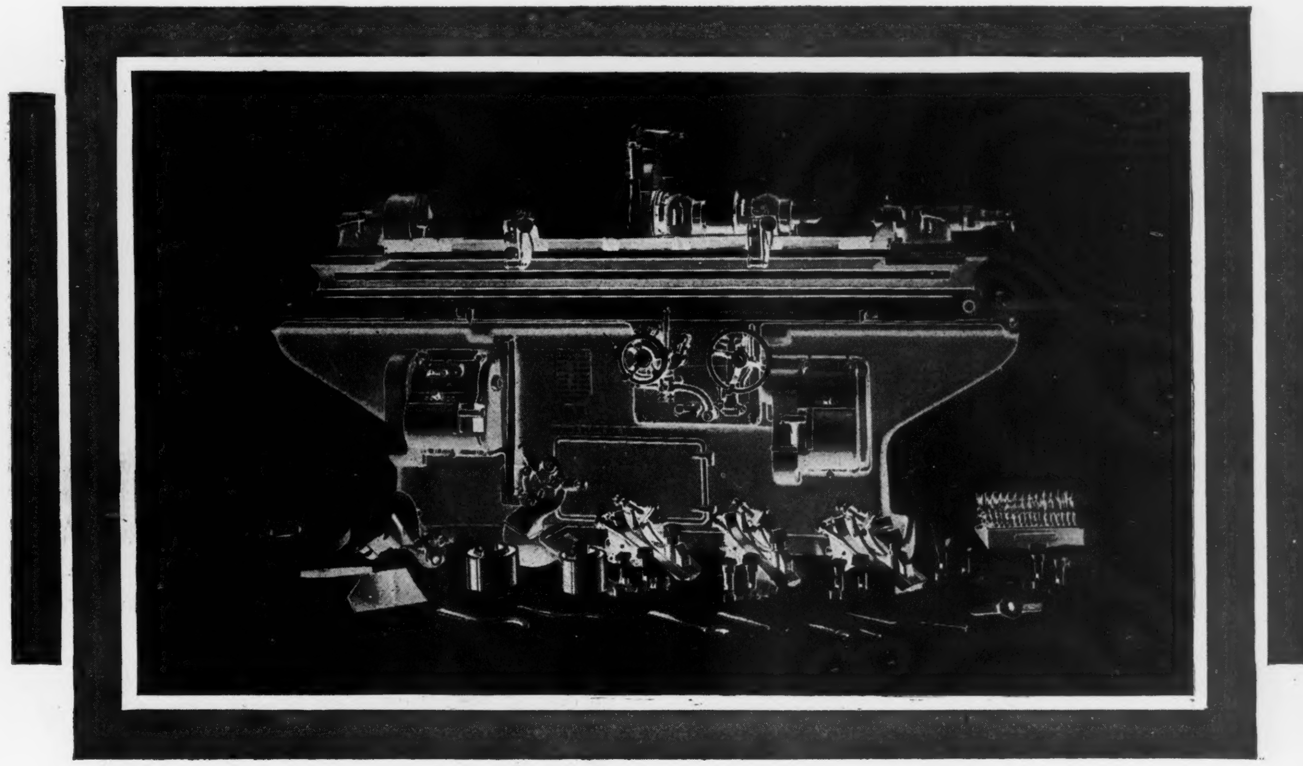
The swivel table is of special design with its face at an angle with the face of sliding table, as is clearly shown by section drawing.

By this construction the thrust, resulting from the wheel pushing against the stock and the downward pull due to rotation of wheel, is resisted by the headstock and footstock in a manner which reduces sliding and twisting tendencies to a minimum.

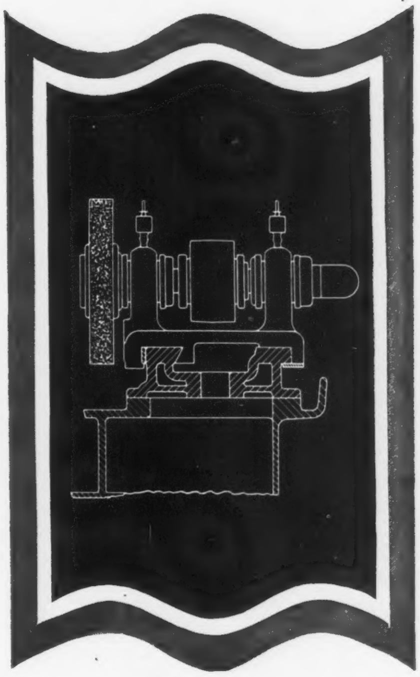
This construction also brings the centres over a solid wall of metal extending directly to the floor.

The low and compact designs of headstock and footstock are of prime importance where permanent accuracy for continuous operation is a requirement.

Brown & Sharpe Mfg. Co.



Plain Grinding Machines Standards of Accuracy



The rigid wheel spindle support with solid walls of base extending to floor, insures absence of vibration which would impair accuracy.

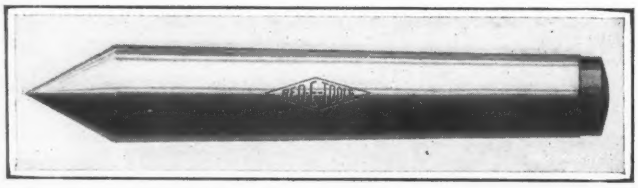
The location of wheel on end of spindle, facilitates the removing and changing—a great asset in production where the same machine must be used for varied set-ups.

The spindle pulleys are easily and quickly changed—one nut being the only adjustment necessary.

These and other features are vital factors to the manufacturer who must maintain a high degree of accuracy.

An industry whose grinding is the product of Brown & Sharpe Grinding Machines is assured of prestige—and in the shop, production and efficiency.

Providence, R. I., U. S. A.



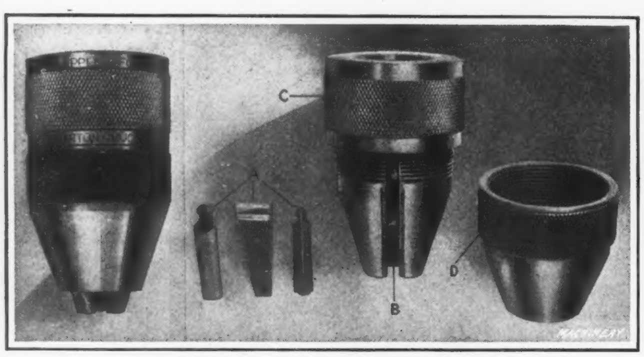
High-speed Lathe and Grinder Center made by the Ready Tool Co.

HIGH-SPEED "RED-E" LATHE AND GRINDER CENTER

For use on lathes and grinding machines the Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn., has developed the "Red-E" high-speed center which is here illustrated and described. It is claimed that this center not only lasts longer, but that its use makes possible the running of machines at their maximum speeds, without danger of burning the centers or having them freeze to the work. Another important claim made for this device is that it eliminates losses resulting from having machines standing idle while centers are being reground or replaced. These "Red-E" centers are made with Nos. 2, 3, 4 and 5 Morse taper, Nos. 7, 9, 10 and 11 B. & S. taper, and Nos. 5 to 12, inclusive, Jarno tapers.

BARTON DRILL CHUCK

A clear idea of the design and construction of a new hand-operated drill chuck recently developed by the H. E. Barton Tool Co., 106 S. Jefferson St., Chicago, Ill., will be obtained by referring to the accompanying illustration which shows one complete chuck and another partially disassembled. Referring to this illustration, it will be seen that the three jaws *A* are furnished with cylindrical shaped heads that fit into grooves *B*. These grooves are cut in the head of the operating screw

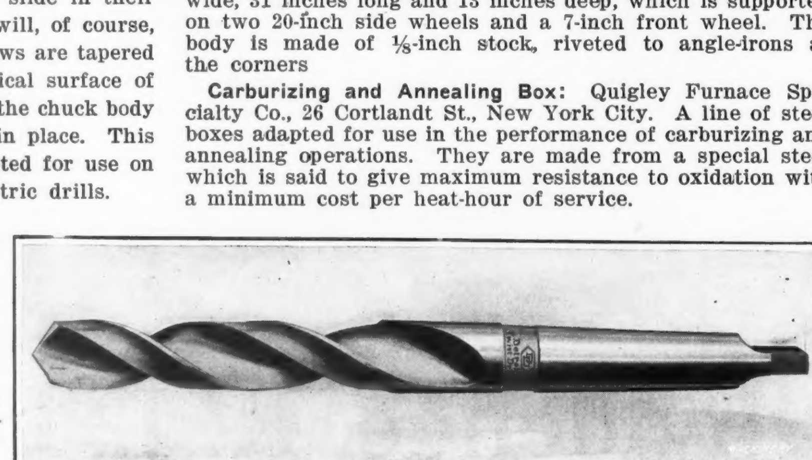


Drill Chuck made by the H. E. Barton Tool Co.

which is threaded into the body of the chuck in such a manner that turning knurled sleeve *C* causes the operating screw to push down or pull up the screw head in which grooves *B* are cut. This causes the jaws to slide in their respective grooves in the chuck body and it will, of course, be apparent that on their outer edges these jaws are tapered and curved so that they conform to the conical surface of the chuck body. Knurled cap *D* is screwed to the chuck body over the jaws to provide for retaining them in place. This is a self-contained, keyless chuck and is adapted for use on high-speed drilling machines or portable electric drills.

DETROIT TWIST DRILL

The Detroit Twist Drill Co., Detroit, Mich., has developed a hot-rolled drill known as the Detroit Double-D. It is made of a tungsten-chrome high-speed steel. The flutes are of unusual width to afford ample chip clearance, and a 32-degree helix angle at the point especially adapts these tools for drilling tough, hard materials. Another feature that adapts these drills for severe service is the graduated thickness of the web which affords ample torsional strength. Drills of this type are furnished in sizes from ½ inch to 1½ inches in diameter.



Double-D Drill made by the Detroit Twist Drill Co. for drilling Forgings, Cored Steel Castings, etc.

MARTIN TOOL-HOLDER

A tool-holder has recently been developed by the Martin Tool Holder Co., of Jackson, Tenn., which provides for utilizing pieces of broken high-speed steel drills, reamers, etc., in making cutter bits for use in the tool-holders. This practice eliminates the waste of expensive high-speed steel scrap which is usually considered valueless except for remelting. In Fig. 1 there is shown a bit made from a broken drill, which clearly illustrates the method of grinding. It is merely necessary to grind a clearance below the cutting edge and

Fig. 1. Martin Tool-holder for Round Bits, in which Broken Twist Drills, etc., can be utilized

Fig. 2. Martin Tool-holder in which the Tool Bit is made from Square Bar Stock

to produce the necessary rake as shown. It is claimed that this is the means of making a perfectly efficient cutter. Martin tool-holders are made in various standard types such as straight, right- and left-hand, cutting off, necking, forming, turning, etc. They are made of tool steel to afford ample strength and durability; and in addition to the holders for round tool bits, as shown in Fig. 1, these holders are made to carry square bits, as illustrated in Fig. 2.

NEW MACHINERY AND TOOLS NOTES

Slip Joint: Fox Machine Co., Jackson, Mich. A universal slip joint which derives its name from the fact that it can be pushed or slipped into position where the joint locates itself firmly, being driven by a key. The joint can also be taken off a shaft without having to remove a taper pin.

Shop Truck: William H. Haskell Mfg. Co., Pawtucket, R. I. A shop truck for general use, with a body 21 inches wide, 31 inches long and 13 inches deep, which is supported on two 20-inch side wheels and a 7-inch front wheel. The body is made of ⅛-inch stock, riveted to angle-irons at the corners

Carburizing and Annealing Box: Quigley Furnace Specialty Co., 26 Cortlandt St., New York City. A line of steel boxes adapted for use in the performance of carburizing and annealing operations. They are made from a special steel which is said to give maximum resistance to oxidation with a minimum cost per heat-hour of service.

Elevating Truck: Lakewood Engineering Co., Cleveland, Ohio. An industrial truck adapted for carrying work and elevating it to the proper height for loading on storage racks or freight cars or for placing on machines.

Ball Bearing Jack: Duff Mfg. Co., Pittsburg, Pa. A 75-ton high-speed ball bearing screw jack adapted for use in handling locomotives and other heavy equipment. In designing this tool, the operating mechanism has been located at the base, bringing the bulk of its weight near the bottom.

Industrial Crane Truck: Elwell-Parker Electric Co., Cleveland, Ohio. A motor-driven truck which receives power from an electric storage battery. This truck is of the elevating type and is furnished with a revolving jib crane which has a capacity for loads up to 1000 pounds at a fixed outreach of 48 inches.

Siren: Inter State Machine Products Co., Inc., Rochester, N. Y. A siren with a weather-proof housing for use as an emergency signal for factories, steel mills, coal mines, etc. This siren may be used either in a vertical or horizontal position. The actuating motor operates on 110-volt direct current or alternating current of any frequency.

Heat-treating Furnace: W. S. Rockwell Co., 50 Church St., New York City. A side-opening furnace which is adapted for handling work that varies considerably in size and shape. This furnace is 36 feet wide and approximately 5 feet long, being divided into seven compartments with provision for combining two or more of the compartments as required.

Radius and Angle Grinding Wheel Dresser: S. L. & M. Sales Co., 408 Moffat Bldg., Detroit, Mich. A tool for use in dressing abrasive wheels that have a curved or angular face. Sufficient capacity is provided for dressing a 12-inch wheel to a radius of from 0 to 1¼ inches, either convex or concave, and flat-faced wheels can be dressed to any desired angle.

Combination Torch and Furnace: North American Mfg. Co., 5902 Carnegie Ave., Cleveland, Ohio. A blow torch combined with a specially built furnace The flame is adjustable from 3 to 24 inches and affords a maximum temperature of 2500 degrees F. The furnace is made of cast iron and lined with firebrick, asbestos being used as an insulating material.

Counterbore: Cost-Cut Counterbore Co., 74-78 Fort St. East, Detroit, Mich. A built-up, renewable counterbore which is made of five pieces, namely, a holder, cutter, pilot pin, pilot bushing, and set-screw. It is claimed that the only parts of this tool that will wear out are the cutter and pilot bushing, and the cutter can be resharpened repeatedly until it is worn out.

Airplane Propeller Forming Machine: Keller Mechanical Engraving Co., 74 Washington St., Brooklyn, N. Y. A machine for this purpose which has cut fifty propellers from the rough in a period of 8½ hours. Two propellers are formed simultaneously but only one blade of each propeller is worked on at a time. A machine of this type can also be utilized for the forming of other wooden products.

Facing and Boring Machine: W. W. Ayre, 303 Fifth Ave., New York City. A tool which is adapted for use on either boring, milling, or drilling machines or turret lathes. Feeding of the tool is accomplished by a star-wheel, and the screw is provided with a micrometer collar, divided in intervals of 0.001 inch. Hence the term micrometer facing and boring machine, which has been given to this tool.

Combination Drill-holder and Size Gage: Russell & Burr, 716 Land Title Bldg., Philadelphia, Pa. A device designed to facilitate the storage of drills according to size, when they are returned to the tool-room. It consists of a cast-iron base, and a hardened steel V-gage with ground edges. Two rows of holes are drilled parallel to the V-gage to accommodate full sets of drills, for instance, No. 1 to No. 60 B. & S. gages.

Industrial Trailer Truck: Warren & Irrgang Co., Springfield, Mass. A Type WJ10 trailer truck which is 36 by 72 inches in size and has a height of 16 inches. This truck is of all-steel construction with the chassis constructed of four 3-inch, 4-pound channels running lengthwise, two for each side, these channels being tied together with ¾- and ⅞-inch truss rods and framed with 2- by 2- by 3/16-inch angle-irons.

Power Hammers: Kaukauna Machine Works, Kaukauna, Wis. This concern has redesigned the Mayer power hammers of its manufacture, which are built with heavy gray cast-iron frames made in a single piece for the smaller hammers and in two parts for the larger sizes. A steel ram operates in V-guides cast integral with the frame. Hammers of this type are built in five sizes with capacities of 25, 50, 100, 250, and 500 pounds.

Crankshaft Lathe: Wickes Bros., Saginaw, Mich. A production machine for use in turning crankshafts, regardless of whether they have one or more throws. In addition, this machine can be readily adapted for facing off the cheeks of the webs. It is built in two standard types, one of which is known as a duplex machine for turning two pieces simultaneously, while the other is styled a universal machine and is suitable for turning one piece at a time.

Micrometer Caliper: Lindquist Engineering Works, Portland, Conn. A micrometer caliper which provides for making direct measurements of 0.0001 inch. It is similar in general design to an ordinary micrometer, although certain modifications were necessary to provide for attaining a greater degree of accuracy in measuring. Micrometers of this type are made in all sizes required for measuring work from ¼ inch to 6 inches in diameter, the total range of each tool being only ¼ inch.

Drilling and Tapping Machine: Landau Machine & Drill Press Co., Inc., 19 W. 44th St., New York City. A drilling machine equipped with the selective turret head that characterizes the tools of this company's manufacture. On the present machine, provision has been made for reversing the direction of rotation to enable tapping operations to be performed. There are four spindles in which different tools may be mounted, any of which may be brought into the operating position.

Camshaft Lathe: Charles Gordon, Inc., Milwaukee, Wis. A machine on which several departures have been made from established practice in designing tools of this general type. For instance, the work travels past the tools to obtain the feed, and the tools are located at the rear of the work which rotates in a direction opposite to that customarily employed. The camshaft forging is supported on centers, and adjustment of the tailstock provides for handling different lengths of shafts up to 60 inches.

Center Drill and Countersink Holder: Lindquist Engineering Works, Portland, Conn. A tool for drilling centers on a lathe, which is designed to overcome the necessity of taking out the tail center and substituting a chuck. This tool is made of a single piece of steel, with a recess to fit over the tail center. The outside of the tool is knurled to enable the operator to hold it between his thumb and finger while performing the centering operation. These tools are made in four sizes for Nos. 13, 30, 46, and 52 drills, respectively.

Plain Cylindrical Grinding Machine: Fitchburg Grinding Machine Co., Fitchburg, Mass. A line of machines of this type, on which the wheel-spindle is made of tool steel and runs in bronze bearings with adjustment for wear. The automatic cross-feed is operated at each reversal of the table and may be set in such a manner that it is self-releasing when the work has been ground to the required size. The table swivels on a central stud and can be set for taper grinding operations. Fine adjustment is furnished for the work-rest to accurately maintain the desired dimensions.

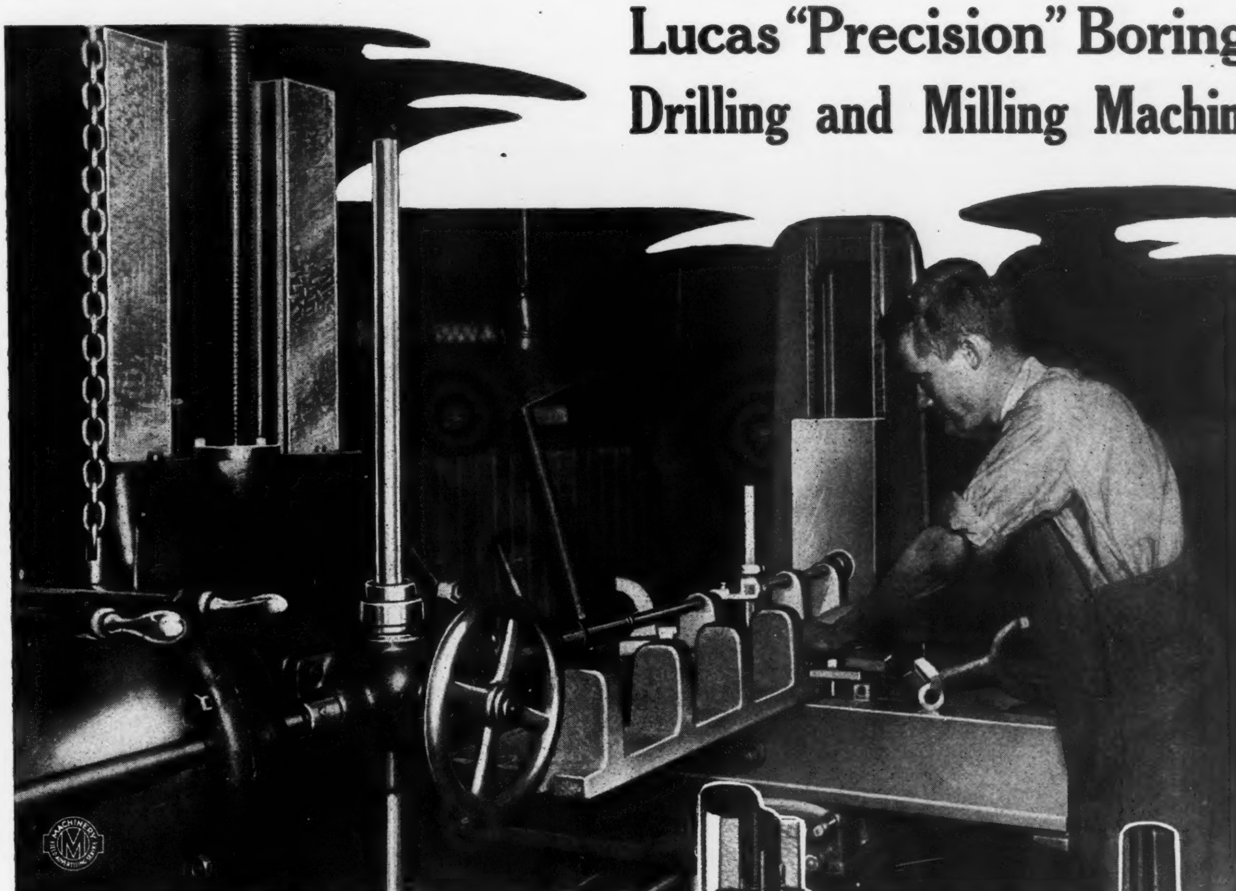
Duplex Thread Grinding Attachment: Precision & Thread Grinder Mfg. Co., 1932 Arch St., Philadelphia, Pa. A duplex attachment that provides for using two wheels to grind a thread, operating at opposite sides of the work. The wheels are beveled so that they grind on opposite sides of the thread; and on production work where a large number of duplicate pieces are to be ground, these wheels are set to the thread of the first part. The threads on following pieces of work are set to the wheels, provision being made for accomplishing this result by means of an adjustable dog.

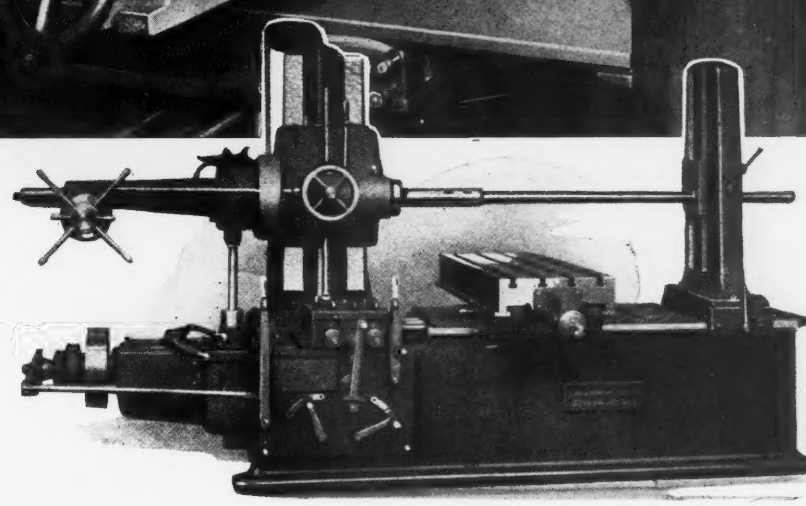
Gun-boring Lathe: William K. Stamets, Pittsburg, Pa. This machine has a bed made in two I-sections with flat ways affording a liberal bearing surface. These two members are connected by inverted U-shape cross members placed at intervals of 24 inches. The headstock totally encloses all working parts and acts as a reservoir for lubricating oil. Submerged in the oil is a gear-driven pump that supplies lubricant to a second reservoir at the top of the head, from which it is conducted through pipes and distributed to all bearings that depend upon this system for lubrication.

Bolt and Nut Machinery: William H. Haskell Mfg. Co., Pawtucket, R. I. A line of machinery adapted for performing hot-forging operations on bolts and cold-punching operations on nuts. To adapt these machines for severe service their design has been carefully worked out to afford ample durability. For instance, all bearings that carry heavy loads are bushed with either babbitt, bronze, steel, or cast iron. This line includes a hot-forging machine for stock up to ¾ inch in diameter, a No. 2 upright shear for cutting round bolt stock of the same size, a long stroke press for trimming the flash from bolt heads, and a two-spindle horizontal bolt milling machine.

Adjustable Milling Cutters: Moback Tool & Machine Mfg. Co., 330 Atlantic Ave., Boston, Mass. Milling cutters made according to a principle of construction which involves the use of clamping wedges to hold the blades in place. Each wedge has three tapers placed to produce a full bearing pressure on the blade which is adjustable to two cutting positions, each blade being provided with two cross-slots for that purpose. After the blades are worn to the end, the clamping wedges are removed and the blades shifted to the second slots, thus doubling their life. When they are worn out the blades can be replaced without discarding the balance of the tool. Cutters of this type are made as end, face and side milling cutters.

Lucas "Precision" Boring, Drilling and Milling Machine





Two in the Kempsmith Toolroom— One Three Years Old, One Six Months—

'Nough said

The Kempsmith Manufacturing Company of Milwaukee, Wis., fully appreciates the advantage of highly accurate jigs and fixtures to assure complete interchangeability and eliminate fitting in assembling. Kempsmith tool-room equipment includes only the most accurate machines, among them two Lucas "Precision" Boring, Drilling and Milling Machines—the performances of the first having sold the second during the past year.

The No. 31 machine is here shown boring a swivel jig used in milling triple gear forks for the Kempsmith Maximiller—a small, but important factor in assuring efficiency to this high class production machine. A Lucas Boring Machine gives prestige to any tool-room and insures work that is accurate within very close limits. Let us tell you more about it.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF CLEVELAND, OHIO, U.S.A.

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Alfred Herbert, Paris. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

PERSONALS

Hugh L. Siegel, formerly general sales manager for the Ford Roofing Products Co., is now associated with the Walter A. Zelnicker Supply Co., St. Louis, Mo., as assistant to the president.

Alfred Spangenberg, formerly superintendent of the Ordnance Department of the Mead-Morrison Mfg. Co., East Boston, Mass., is now superintendent of the Reading Valve & Fittings Co., Reading, Pa.

Robert P. Leopold, formerly chief master gage inspector at Frankford Arsenal, Philadelphia, Pa., is now mechanical engineer with the C. Walker Jones Co., Philadelphia, Pa., manufacturer of knitting needles.

H. C. Barnes has joined the Allegheny Gear Works, Pittsburg, Pa., as superintendent of laboratory and metallurgical work. Mr. Barnes is a technical graduate with more than ten years practical experience.

Irving H. Jones has become associated with the machinery department of Joseph T. Ryerson & Son, Chicago, Ill., and will specialize in sales engineering work on the Ryerson line of machine tool equipment.

E. W. Bernhard, for a number of years connected with the Hess Bright Mfg. Co. of Philadelphia, Pa. as planning manager, has been made assistant to the general factory manager. H. W. Jackson has been promoted to the position of factory manager.

L. R. Meisenhelter has been appointed special representative of the Houston, Stanwood & Gamble Co., Cincinnati, Ohio, manufacturer of large lathes, and will devote his entire time to the sale of this company's line of lathes. Mr. Meisenhelter has disposed of his interest in the L. R. Meisenhelter Machinery Co.

J. George Leyner has resigned as president of the J. George Leyner Engineering Works Co., Littleton, Col., and is now devoting all his time to the Leyner Tractor & Mfg. Co., 212 Tramway Bldg., Denver, Col., organized for the manufacture and sale of the Linapede tractor, the design of which has recently been improved by Mr. Leyner.

J. T. MacMurray, formerly works manager of the Mead-Morrison Mfg. Co., East Boston, Mass., has become vice-president and general manager of the Reading Valve & Fittings Co., Reading Pa. While with the Mead-Morrison Mfg. Co. Mr. MacMurray had charge of the building of six hundred 4-inch naval gun mounts for the U. S. Navy.

Oscar William Schricker has been appointed assistant superintendent of the machine shop in the Department of Mechanical Engineering, University of Illinois, Urbana, Ill. He attended the Rankin School of Mechanical Trades and has had fourteen years' experience as a toolmaker, foreman, and chief inspector in various manufacturing plants.

Frank R. Bacon, president of the Cutler-Hammer Mfg. Co., Milwaukee, Wis., has been elected chairman of a new organization in Milwaukee known as the American Constitutional League, the activities of which will be confined solely to Americanization work and which will embrace all forms of education and publicity in favor of Americanization.

R. B. Woolley, who has been director of publicity for the Society for Electrical Development, Inc., for the last two years, is now with Thomas F. Logan, Inc., advertising agency, 680 Fifth Ave., New York City. Mr. Woolley has been serving seventeen years in sales and advertising capacities. He will specialize on electrical and merchandising accounts.

A. E. DeClercq has recently joined the Cleveland sales force of the Tacony Steel Co., Philadelphia, Pa. Mr. DeClercq has been assigned to the territory of Detroit and vicinity. He is a metallurgist of twelve years' experience, having been connected with the Timken-Detroit Axle Co., Park Drop Forge Co., Chalmers Motor Car Co., and Fisher Body Corporation.

A. A. Blue has been placed in charge of the heat-treating department of the Duff Mfg. Co., Pittsburg, Pa. Mr. Blue is a graduate of the Chemical Engineering Department of Cornell University. For two years he was connected with the Midvale Steel Co. in the heat-treating department, and during the war served as assistant superintendent of heat-treating and forge shop in the gun plant of the Watertown Arsenal.

Arthur Elliot Allen has been appointed district manager at New York City for the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., to succeed Edward D. Kilburn, who has been elected vice-president and general manager of the Westinghouse Electric International Co. Mr. Allen has been associated with the company since 1902, and previous to his present appointment, was executive assistant to the manager of the New York office.

Roswell Miller Rennie has been appointed superintendent of the machine shop in the Department of Mechanical Engineering, University of Illinois, Urbana, Ill. He is a graduate of the Massachusetts Institute of Technology, and was engaged in research work for one year and in production and experimental work in aeronautics for the United States Navy, including technical editorial work for the Aeronautical Personnel Training Section of the Navy.

Clyde W. Blakeslee has resigned from the management of the Chicago store of the Abrasive Co., and will take up the duties of sales manager (domestic and foreign) for N. A. Strand & Co., 625 Jackson Blvd., Chicago, Ill., manufacturers of flexible shafts and equipments. Mr. Blakeslee will be in charge of the salesroom and office which has been opened at Room 201, Machinery Hall, Chicago, for the convenience of the trade in the machinery district, and out-of-town visitors.

P. J. Flaherty was elected president of the Johnson Bronze Co., New Castle Pa., at a recent meeting of the board of directors, to fill the vacancy created by the death of G. W. Johnson. Mr. Flaherty has actually been the executive head of the company since January, 1909. He was the chief factor in developing the automobile and bronze bushing part of the business. The company now manufactures every style of bronze bushing in all sizes and for all purposes, specializing particularly on automobile equipment.

S. M. Wetmore has been appointed district sales manager of the Detroit territory for the Hammond Steel Co., Inc., Syracuse, N. Y., manufacturer of high-grade tool and alloy steels and die-blocks, with offices at 912-915 Kresge Bldg., Detroit, Mich. Mr. Wetmore has had twenty-five years of practical experience with alloy and special steels. The Hammond Steel Co. has recently installed, and has in full operation, additional electric furnaces and large rolling and finishing mills to take care of its increased business.

C. N. Kell has been appointed assistant to the general manager of the forge department of the Duff Mfg. Co., Pittsburg, Pa., manufacturer of lifting jacks. For the last eight months he has been assistant to the general superintendent of this company in charge of efficiency work. Mr. Kell designed the equipment of the Rock Island Arsenal for testing the recoil mechanism of the French 75-millimeter gun. His previous experience included work as mechanical engineer with the Mandel Corporation of Chicago, and as assistant superintendent of the Denny Tractor Co., Cedar Rapids, Iowa.

Jesse Benjamin Kommers has been appointed special research associate professor of engineering materials, on the investigation of the fatigue of metals in the Engineering Experiment Station of the College of Engineering, University of Illinois, Urbana, Ill. He graduated from the University of Wisconsin with the degree of Bachelor of Science in electrical engineering, and was instructor in mechanics and assistant professor of mechanics at the University of Wisconsin. Mr. Kommers was granted leave of absence from the university to assist in the important investigation on the fatigue of metals that has just been undertaken in the University of Illinois in cooperation with the Engineering Foundation and National Research Council.

Matthew Rutherford Riddell has been appointed assistant professor of aeronautic engineering and assistant to the director of the Engineering Experiment Station of the College of Engineering, University of Illinois, Urbana, Ill. Mr. Riddell is a graduate of the University of Toronto and has been instructor and lecturer in mechanical engineering in that university. He afterward engaged in organizing two companies for the manufacture of electrical heating goods and signs, and was later chief draftsman for the Curtiss Aeroplanes & Motors, Ltd. He was also connected with the Canadian Aeroplanes, Ltd., of Toronto, in the capacity of chief draftsman, testing engineer, and chief engineer, and had a prominent part in directing war work.

Edward A. Woodworth and C. E. Laverenz have been appointed special railroad representatives of the Chicago Pneumatic Tool Co., attached to the staff of manager of western railroad sales, with headquarters at the Fisher Bldg., Chicago, Ill. Mr. Woodworth has been for several years secretary of the Committee on Standards, U. S. Railroad Administration, Washington, D. C., and prior to engaging in government service, he was associated with the Oxweld Railroad Service Co. and the O'Malley Barre Valve Co. He was formerly chief clerk and general mechanical superintendent of the Chicago, Rock Island & Pacific Railroad, and has had experience in the shops of that road as a mechanic. Mr. Laverenz was for several years an inspector in the Ordnance Department of the U. S. Navy, and previously held positions as boilermaker and foreman of the Chicago & Northwestern, and Illinois Central Railroads.

Edward D. Kilburn, who has been New York district manager of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., since March, 1917, was recently elected vice-president and general manager of the Westinghouse Electric International Co. Maurice Coster, who has been actively engaged for more than thirty years in handling the foreign interests of the Westinghouse company, continues as vice-president of the Westinghouse Electric International Co. with

advisory duties. The president of the company is LOYALL A. OSBORNE, who is senior vice-president of the Westinghouse Electric & Mfg. Co., and was actively engaged in national work during the war. The Westinghouse Electric International Co. was formed in the spring of 1919 to succeed the Westinghouse Electric Export Co. The new company handles the Westinghouse foreign business and is world-wide in its scope, exclusive of the United States and Canada.

OBITUARIES

CHARLES A. SWAINE, president of the Fred I. Swaine Mfg. Co., St. Louis, Mo., died December 31.

GEORGE RHODES CULLINGWORTH, vice-president of the Garvin Machine Co., New York City, died December 15 in his eighty-third year. Mr. Cullingworth was born August 24, 1837 in Manayunk, Pa., which was then a suburb of Philadelphia. He attended public school there until he was about sixteen years of age, when he entered business with his father in Philadelphia, where he served his apprenticeship. In 1857, he went to work for Bennett, Dougherty & Sons of Philadelphia, leaving there in 1859 to go to the Colts Armory in Hartford. From there he went to the Star Armory at Yonkers as a toolmaker, and from Yonkers, to a gun shop in Trenton, N. J., where he had a contract for making guns. In 1865 he was employed by E. E. Garvin & Co., leaving there in 1870 to form a partnership with Sargent. He also did some work in the erection of the elevated railroad in New York City, at which time he invented the ticket chopper that is now in use. After selling out his interest in the Ingersoll-Rand Co., he went to work for the Garvin Machine Co. He was a member of the American Society of Mechanical Engineers.

ALBERT SCHMID, who represented the interests of the Westinghouse Lamp Co. abroad and who held the position of consulting engineer for the American Westinghouse Co., died December 31. Mr. Schmid had been closely identified with the early development of electrical machinery in the United States, and was also prominent in the electrical world of France, Switzerland, Italy, and Great Britain. He was born in Zurich, Switzerland, in 1857 and received his education in that city. He started his career in the employ of the French Westinghouse Air Brake Co., and it was there that Mr. Westinghouse met him in the early eighties and being impressed by his ability invited him to come to America. Soon after his arrival in this country he engaged in designing work for the Westinghouse Air Brake Co., then located in Allegheny, Pa., where his keen mechanical perception and insight brought him rapid advancement. When Mr. Westinghouse became interested in the Union Switch & Signal Co., he engaged Mr. Schmid as the chief designer and engineer in that field. He was afterward transferred to the newly created Westinghouse Electric Co., becoming its first chief engineer and later its general superintendent. In 1897, he went to Europe for the purpose of studying the continental development in the electrical art and the manufacturing possibilities there, and as a result of this trip the French Westinghouse Co. was formed of which he was made director general. He has also held the positions of a director of the Westinghouse Electric Co. Ltd. of England, and president of the Campagnie des Lampes a Filament Metallique, of France. Mr. Schmid was directly concerned with the original development of many forms of electrical apparatus, including the modern industrial motor, electric railway motor, and transformer. He was also granted a number of patents for electrical machines and apparatus. In addition, he did much to develop the gas and gasoline engine, and his latest work was on a carbureting system for internal combustion engines.

COMING EVENTS

February 2-6—First annual mechanical inspection equipment exposition and convention of the American Society of Mechanical Inspectors, on the Roof of the Hotel Astor, New York City. Secretary, Henry F. Winter, 35 W. 39th St., New York City.

February 17-19—National conference on concrete house construction at the Auditorium Hotel, Chicago, Ill. Secretary, A. J. R. Curtis, 111 W. Washington St., Chicago, Ill.

February 26—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 547 Arnett Blvd., Rochester, N. Y.

March 6-13—Second annual aeronautical exposition, held by the Manufacturers' Aircraft Association, Inc., 501 Fifth Ave., New York City, in the Seventy-first Regiment Armory, Thirty-fourth St. and Park Ave., New York City.

March 9-11—First Annual New England Industrial Accident Prevention Congress, held at Hotel Bancroft, Worcester, Mass.

May 12-15—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

May 20-21—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J.; headquarters, Hotel Traymore. Secretary, Charles E. Hildreth, Worcester, Mass.

May 24-27—Spring convention of the American Society of Mechanical Engineers at St. Louis, Mo.; headquarters, Hotel Statler. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

North Carolina State College of Agriculture and Engineering, West Raleigh, N. C. Catalogue for 1918-1919, with calendar for 1919-1920, list of courses, etc.

School of Mines and Metallurgy of the University of Missouri, Rolla, Mo. Bulletin containing a bibliography on the roasting, leaching, smelting, and electrometallurgy of zinc, compiled by Harold L. Wheeler, librarian of the university.

University of Illinois, Urbana, Ill., announces that the Engineering Experiment Station of the university, in order to assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, maintains fourteen research graduate assistantships. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $500 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. Additional information may be obtained by addressing the Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

BOOKS AND PAMPHLETS

Publications of the Bureau of Standards. 149 pages, 7 by 10½ inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 24 of the Bureau of Standards. Price, 25 cents.

This circular contains a list of the scientific and technologic papers as well as all the circulars and miscellaneous publications issued by the Bureau of Standards.

Principles of Industrial Organization. By Dexter S. Kimball. 325 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., New York City. Price, $3.

This is the second edition of the author's work on "Industrial Organization." In revising the book, the contents have been somewhat rearranged with the view to making the sequence of the discourse more logical. Some new subject matter has also been added in order to make the book more serviceable as a text-book, as well as of greater value to engineers engaged in practice. The book is divided into sixteen chapters, headed as follows: Fundamental and Historical; the Industrial Revolution; the Effects of the Great Inventions; Modern Industrial Tendencies; Forms of Industrial Ownership; Principles of Organization—System; Planning Departments; Principles of Cost Keeping; the Depreciation of Wasting Assets; Purchasing and Storing of Materials; Standards and Their Attainment; Location, Arrangement and Construction of Industrial Plants; Problems of Employment; the Compensation of Labor; Corrective Influences—Employes' Service; Resume—Theories of Management. The work is specifically of value as a text-book and has been so designed by the author, who is Professor of machine design and construction at Cornell University.

Foundry Cost Accounting. By Robert E. Belt. 271 Pages, 5½ by 8½ inches. Published by the Penton Publishing Co., Cleveland, Ohio. Price, $5.

The author of this book, who is a certified public accountant and the cost accountant of the American Malleable Castings Association, has aimed to set forth in this volume in a simple and direct manner the practical principles of accounting that are applicable to the foundry industry, and to show methods of collecting the cost data and of accurately determining production costs. The aim has also been to impress upon the executive and the management the importance of an accurate knowledge of costs and the dangers of a price policy that is not founded on production costs. The book is divided into twelve chapters headed as follows: Importance of an Accurate Knowledge of Costs; Uniform Cost Finding Methods and the Effect on Competition; Examining of Plant Practices and Operating Conditions; Installing and Operating a Cost System; Accounting Practice and Records; Operating Departments and Department Records; Classification and Definition of Accounts; Monthly Statements; Product Costs; Depreciation; Estimates and Quotations; and Profits. While there are many of the more successful foundries in the country that have good cost systems, most foundries do not have such systems and it is hoped that this volume will aid the latter class.

Electric Arc Cutting and Welding. 90 pages, 5 by 7 inches. Numerous illustrations. Published by the Electric Arc & Welding Co., 222 Halsey St., Newark, N. J. Price, $1.25.

This book deals with electric arc cutting and welding by alternating current and is intended as an instruction handbook for setting up and operating alternating-current cutting and welding machines and electrodes. It contains, in addition, a great amount of useful data on electric welding of different materials. The book has been especially prepared as a text-book for the welding school that is operated by the company at its plant, but it is also sold to the general public, and copies are distributed free of charge to customers who order either welding machines or quantities of electrodes. The book is divided into lessons, each illustrated with clear and simple line illustrations, the lessons dealing with the following subjects: Setting up and Operating; Welding Terms and Materials; Beading Method; Spreading Method; Padding Method; Fillet Method; Butt-welding Method; Special Butt-welding Method; Irregular Tube Welding; Tack Welding; Sheet Patching Welding; Heavy Section Welding; Cast Iron Welding; Non-ferrous Welding Methods; Preheating, Reheating, and Annealing; Cutting with the Electric Arc: Temperature and Heat of the Arc. A special feature of the book is the simplicity with which the instructions are given, making it possible for any operator to obtain from it the meaning that the author has intended to convey.

Applied Science for Metal-workers. By W. H. Dooley. 479 pages, 5 by 7¼ inches. Published by the Ronald Press Co., 20 Vesey St., New York City. Price, $2.

This is a text-book treating of the principles of physics, chemistry, and other sciences, and their application to shop work, the intention being to correlate these principles with shop observation and experience. The book is intended for use in technical, industrial, apprentice, and continuation schools, and for science classes in secondary schools. It has been written entirely from the practical point of view, the questions at the end of each chapter being so formulated as to bring out the application of the principles to the everyday work of the shop. The style is simple, clear, and concise, the student being led gradually from the elementary to the more difficult phases of the subject. The text is divided into thirty-seven chapters, headed as follows: Science and the Properties of Matter; Weights and Measures; Mechanical Principles of Machines; Leverage; Pulleys, Inclined Planes and Wedges; Laws of Motion; Mechanics of Liquids; Properties of Gases; Heat and Expansion; Light, Color and Sound; Principles of Chemistry; Acids, Alkalies, and

Salts; Physico-chemical Processes; the Chemistry of Common Industrial Substances; Magnetism and Electricity; Frictional or Static Electricity; Generation of Electricity on a Commercial Basis; Transmission of Electrical Energy; the Telephone and Telegraph; Science Underlying Mechanical Drawing Supplies; Strength of Materials; Common Fastening Agents; Common Hand Tools; Transmission of Power; Boilers and the Generation of Steam; the Steam Engine; Methods of Heating; Ventilation; Gas Engines; Iron and Iron Molding; Problems in Patternmaking; the Making and Working of Wrought Iron; the Making and Working of Steel; Structural Steel; Machine Shop Practice; Sheet Metals; Plumbing and Water Supply.

NEW CATALOGUES AND CIRCULARS

Fafnir Bearing Co., New Britain, Conn. Calendar for 1920, advertising Fafnir ball bearings.

National X-Ray Reflector Co., Chicago, Ill. Calendar for 1920, illustrating reflectors for factory lighting and other lighting purposes.

Shepard Electric Crane & Hoist Co., Montour, Falls, N. Y., manufacturer of cargo-handling machinery, is distributing a calendar for 1920.

General Electric Co., Schenectady, N. Y. Calendar for 1920, showing views of electrical equipment and installations made by the company.

E. W. Bemis Machine Co., Worcester, Mass. Leaflet illustrating and describing the Bemis collet lathe chuck and the Bemis milling and auxiliary lathe head.

Pangborn Corporation, Hagerstown, Md. Circular reproducing letters from users of Pangborn sand-blast equipment, concerning the service obtained from it.

Urban Machine & Tool Co., 2424 St. Clair Ave., Cleveland, Ohio. Circular describing and giving specifications for the Urban direct-motor-driven screw-cutting bench lathe.

Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn. Catalogue of Veeder products, including cyclometers, odometers, counters, speed-counters, tachometers and fine die-castings.

Western Tool & Mfg. Co., Springfield, Ohio. Circular illustrating and giving tables of dimensions, prices, etc., of the "Champion" line of vises and the "Champion" surface table.

Portland Cement Association, 111 W. Washington St., Chicago, Ill. Circular treating of concrete chimneys, illustrated with views of chimneys that have been constructed for various manufacturing plants.

Holz & Co., Inc., 17 Madison Ave., New York City. Bulletin 22-23, descriptive of the Holz universal photomicrographic and photomacrographic metallographic bench for magnifications from 1 to 3500 diameters.

Material Handling Machinery Manufacturers' Association, 35 W. 39th St., New York City. Pamphlet entitled "The Right Arm of Industry," outlining the purposes, organization, and work of the association.

Oliver Machinery Co., Grand Rapids, Mich. Circular illustrating and describing the Oliver No. 1 universal woodworker's vise, which can be rapidly adjusted to any desired angle for holding work of irregular shape.

Kent Vacuum Cleaner Co., Inc., Rome, N. Y. Circulars descriptive of the "Vacuna" vacuum cleaners for factory use and the "Utility" floor machine for polishing, scrubbing and sandpapering all kinds of floors.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular 1615, entitled "Westinghouse Underfeed Stoker," describing the leading features of design, principles of operation, efficiency, and capacity of this apparatus.

Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. Circular entitled "Plug that Hole with the Periodograph," advertising the use of the "Periodograph" for making records of costs, and thus avoiding leaks in production.

Wellman-Seaver-Morgan Co., Cleveland, Ohio. Calendar for 1920, illustrating the company's products of cranes, rolling mill machinery, electric hoists, reversing valves, loading and unloading equipment, gas generators, etc.

Products Sales Co., 606 Security Bldg., Milwaukee, Wis. Circular containing information on "Babbittrite" compound, for holding hot metals of all kinds, as for example, for holding babbitt metal while pouring journal boxes.

Davis-Bournonville Co., Jersey City, N. J. Bulletin of Davis-Bournonville lead burners' outfits, for welding lead sheets, storage battery connections, lead pipes, chemical apparatus, and all lead work that must be autogenously welded.

Griscom-Russell Co., 90 West St., New York City. Bulletin 231, descriptive of the Griscom-Russell instantaneous water heater for use in factories or other places requiring large quantities of water to be heated by live or exhaust steam.

Ohio Cultivator Co., Bellevue, Ohio. Leaflet descriptive of the Ohio automatic belt power baling press for use in salvage departments for rapidly baling all compressible materials into heavy bales of convenient size for handling, storing, or loading.

Jackson Compressor Co., Inc., Denver, Col. Bulletin 3, illustrating and describing the Jackson rotary compressor, which is made in capacities varying from 100 to 190 cubic feet of air per minute to meet various requirements in pressure, volume, and horsepower.

Summit Machine Works, Worcester, Mass. Catalogue of lathes, illustrating and describing Summit screw-cutting engine lathes of both the floor and bench types. The lathes shown include 10-inch screw-cutting engine lathes and 10-20 inch screw-cutting gap engine lathes.

Magnetic Mfg. Co., Milwaukee, Wis. Bulletins F, H, and L, descriptive of the three types of magnetic separators made by this company, for removing valuable metal from foundry and shop refuse. Bulletin P, descriptive of magnetic pulleys and magnetic pulley separators.

Walter A. Zelnicker Supply Co., St. Louis, Mo. Bulletin 275, containing a list of new and second-hand equipment, including rails, cars, locomotives, and other machinery and equipment used in the operation and maintenance of railroads, power plants, mines, and industrial plants.

Nelson Valve Co., Chestnut Hill, Philadelphia, Pa. Catalogue 10, covering bronze, iron, and steel valves made in gate, globe, check, and non-return patterns, which include types for practically every class of service found in power plant work, industrial establishments, and large building construction.

Standard Machinery Co., Auburn, R. I. Catalogue for 1920, illustrating and describing the line of rolling mills produced by the company, which are made in eight sizes, ranging from 3 by 5 to 12 by 18 inches. These mills may be equipped either with direct motor drive or friction clutch drive.

Union Switch & Signal Co., Swissvale, Pa. Circular of truck forgings and forgings for automobile and tractor work. Bulletin illustrating the latest types of forgings made by this concern, including crankshafts, camshafts and other automobile forgings, gear blanks, truck and tractor forgings, airplane forgings, etc.

Service Engineering Co., 25 Church St., New York City. Pamphlet containing a synopsis of the engineering service rendered by this concern, which covers consulting engineering, plant and machine tool appraising, planning, complete tooling systems, designing and building of tools, special and automatic machinery, and the development of inventions.

Lafayette Tool & Equipment Co., 21 S. 12th St., Philadelphia, Pa. Catalogue illustrating and describing the Lafayette universal grinder—a precision tool, designed for grinding threaded and plain cylindrical, internal, surface, cutter and tool work. It may be used on the bench or in conjunction with the lathe, shaper, milling machine, die-sinker, planer, boring mill, etc.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Circular descriptive of the technical night school maintained by the company for the benefit of its employes, containing announcements of courses for 1919-1920. The courses cover machine shop practice, blueprint reading, shop drawing, machine design, shop mathematics, practical electricity, shop mechanics, business English, typewriting, hygiene and health, and office training.

Fairbanks Co., 416 Broome St., New York City. Circular of the micro-automatic taper cutting and turning tool made by the Cruban Machine & Steel Corporation, 2 Rector St., New York City. The tool is adaptable for use on hand or automatic screw machines or lathes, and is made to cut tapers of from 1/16 to 3/4 inch per foot and up to 6 inches in length, or any irregular degree of taper within these limits.

N. B. Payne & Co., 25 Church St., New York City. Bulletin treating of the Lane electric cranes, which are manufactured by the Lane Mfg. Co., Montpelier, Vt., for which N. B. Payne & Co. are the sole agents. The bulletin illustrates and describes several styles of cranes, and gives a complete set of specifications, as well as a questionnaire for use of the prospective purchaser. A free copy will be mailed upon request.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Booklet entitled "Westinghouse Opportunities for Technical Graduates," describing the plan developed by the company for the training of graduates of technical schools at all its various works, in order to round out the students' egineering training by practical experience. Copies of the booklet will be sent to anyone interested, upon application to the Educational Department at East Pittsburg.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. Book 375, treating of Link-Belt freight and package handling machinery and other labor-saving elevators and conveyors. Book 380, of Link-Belt electric hoists and overhead cranes. Booklet containing an article entitled "Handling Coal and Ashes with Electric Hoists" by James Monroe, reprinted from "Power Plant Engineering," and illustrated with views showing Link-Belt equipment used for this purpose.

Smalley-General Co., Inc., Bay City, Mich. Circular containing suggestions to manufacturers who are interested in thread-milling, and giving a list of questions which should be filled out when manufacturers contemplate buying thread-milling machines, so that the requirements of the purchaser will be fully met. General bulletin F, giving data on nine common thread-milling jobs, which, it is claimed, can be done to better advantage on a thread-milling machine than by any other method.

Heald Machine Co., Worcester, Mass. Loose-leaf catalogue of Heald grinding machines and magnetic chucks, illustrating and giving specifications for the various styles of cylinder, internal, rotary, and surface grinding machines made by this company. Loose-leaf catalogue entitled "Heald Machines in Operation" containing bulletins showing the wide variety of work that can be performed on Heald grinding machines. These bulletins are illustrated by views taken in the shops, showing the machines engaged on various classes of grinding operations.

Jones & Lamson Machine Co., Springfield, Vt. Publication entitled "Hartness Screw Thread Comparator," a device intended for the accurate and rapid gaging of screw threads. This book, containing 46 pages, 6 by 9 inches, and substantially bound in cloth, contains a complete description of the construction and use of the Hartness screw thread comparator, which was briefly described in the January number of MACHINERY. It illustrates the uses to which the instrument may be put and calls attention to many of the difficulties arising from incorrect screw threads.

Brown Instrument Co., Philadelphia, Pa. Catalogue 12, containing 88 pages, 8 by 10½ inches, covering the complete line of Brown indicating and recording instruments, which include pyrometers, resistance thermometers, recording thermometers, pressure gages, draft gages, tachometers, time and operation recorders, etc. The catalogue describes fully the construction of the pyrometers, and contains views showing their use for heat-treating and hardening, in blast furnaces, in cement plants, in foundries, for galvanizing and tinning, and for many other purposes.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Booklet A, describing Cutler-Hammer motor-operated brakes for alternating-current service, made for application on cranes, elevators, mine hoists, and other kinds of conveying and hoisting machinery. Booklet S, illustrating and describing the Cutler-Hammer magnetic separator pulley, which is used for removing iron from crushing, grinding, or cutting machinery; for the recovery of iron from refuse sands in foundries; and for the purification of products. These publications are both revised and reprinted in their present form.

Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill. Circular descriptive of the "Marvel" all-steel punch, shear, and bender—a machine which is equipped with tool-holding bars in which punches and dies, shears, and benders can be clamped for performing punching, shearing, and bending operations simultaneously or separately. Special tools to suit various requirements can, of course, be used in place of those mentioned. The machine is made in two styles, the larger size having an eccentric and link arrangement at both ends for applying pressure to the tool-holding bars, while the smaller size has only one such arrangement.

Climax Molybdenum Co., 61 Broadway, New York City. New 72-page book entitled, "Molybdenum Commercial Steels," which comprises practically a treatise on the subject. Data are given on the commercial production and use of these steels, and the text of the book is supplemented by many tables and colored charts as well as by photomicrographs. The book treats fully of the physical properties and the heat-treatments of the various types of molybdenum steels developed during the war and since. The material presented has been read and approved by prominent metallurgists and alloy steel manufacturers having a wide experience with molybdenum steels. The Climax Molybdenum Co. is associated with the American Metal Co., Ltd., the New York offices of both companies being at 61 Broadway. A copy of the book will be sent free upon request.

Alfred Herbert, Ltd., 54 Dey St., New York City. Bulletin 51, containing a reprint of three articles on cutting tools, from the "Monthly Review of Modern Machine Shop Practice." The first article treats of the design of lathe, planer, shaper, and slotter tools; the factors which decide what shape of tool will prove most efficient for any given cutting operation; the ideal tool to use for a known combination of factors; and the effect on the shape of the tools due to variation in these factors. The second article deals with the practical side of the subject of cutting tools, including their selection, use, manufacture, storage, and maintenance, and describes a set of standard tools that will cover general requirements. The third article entitled "The Toolmaking Department" contains suggestions regarding the equipment of a toolmaking plant. In connection with the latter article, a description is presented of the construction and operation of the Lumsden oscillating tool grinder.

Blanchard Machine Co., 64 State St., Cambridge, Mass. Operators' handbook for the Blanchard high-power vertical surface grinder, sizes 10 and 16. This book has been published primarily for the use of the operator and foreman in charge of the machines, with the idea of enabling them to obtain the maximum results from Blanchard surface grinders. The book, however, should also be of value to tool designers and to maintenance and repair men. In addition to containing full directions for the operation of the machine, information is given on the selection of wheels for grinding various materials. It is pointed out that it is of the utmost importance to select the right wheel for the job, and several pages are devoted to this subject. Information is also given in regard to the magnetic chuck, the best means of chucking various kinds of work, and how to utilize the magnetism through simple magnetic fixtures for holding irregular shaped pieces. The adjustment and repair of these machines is also fully covered. Free copies of the book will be sent upon request.

TRADE NOTES

Hewitt Co., 9th Ave. and 13th St., Maywood, Ill., desires to obtain catalogues and printed matter on machine shop equipment of all kinds, as it expects to be in the market soon for equipment of this class.

Duff Mfg. Co., Pittsburg, Pa., has opened a branch sales office in the Book Bldg., Detroit, Mich., in charge of Frank J. Hunt. The new office will handle the output of the forge department of the company.

Ross Mfg. Co., Cleveland, Ohio, manufacturer of emery wheel dressers, has moved into its new plant at 3160 W. 106th St. This will enable the company to fill new orders promptly because of the increased capacity of the plant.

C. F. Braun & Co., San Francisco, Cal., announce that they have secured for their executive and engineering offices the entire tenth floor of the Atlas Building, 604 Mission St., which will bring them into closer touch with their factory.

L. Best Co., distributor of Sterling wheels, made by the Sterling Grinding Wheel Co., Tiffin, Ohio, has recently purchased a building at 28-30 West Broadway, which will afford ample space for the increased business to which the company looks forward in 1920.

M. Freedman & Bro., 78 Duane St., New York City, die-cutting specialists, announce that Albert Freedman has purchased his brother's interest in the business, and that Maurice Grailtzer has become a junior partner in the firm, which will continue under the same name as formerly.

Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago, Ill., has opened a New York office at 350 Broadway for the distribution and sales of its furnaces, forges, and heat-treating equipment. J. W. Lazear formerly with the Brown Instrument Co., in Chicago, will be in charge of the new office.

Richardson-Phenix Co., Milwaukee, Wis., lubrication engineers and manufacturers, have opened an office at 306 American Trust Bldg., Birmingham, Ala. James D. Scruggs, who has been associated with the Hills-McCanna Co., has been appointed district manager of the southern office.

Massachusetts Blower Co., Watertown, Mass., has reopened its Boston office, which is now located in the Kimball Building, 18 Tremont St., Boston, in charge of A. C. Bartlett. All inquiries regarding prices and the application of the company's apparatus should be referred to the Boston office.

Black & Decker Mfg. Co., 10 Guilford Ave., Baltimore, Md., has established a branch office at 6523 Euclid Ave., Cleveland, Ohio. Garth A. Dodge, formerly connected with the Austin Co., will be in charge of the Cleveland branch. Mr. Dodge is branch manager for the states of Ohio and Indiana.

Victor Saw Works, Springfield, Mass., held its annual salesmen's convention at Springfield on January 2 and 3. The activities of the past year were reported and satisfaction was expressed at the progress that had been made. The company announces that the prospects for 1920 are particularly good.

Star Tool & Mfg. Co., 4518 Lexington St., Chicago, Ill., announces the following changes in its personnel: C. C. Poucher is president and general manager; J. R. Richer, vice-president and chief engineer; J. O. Hessler, treasurer and superintendent; and E. J. Dumroese, secretary and office manager. These men will also comprise the board of directors.

T. A. Willson & Co., Inc., Reading, Pa., manufacturer of safety goggles and glasses for industrial and other uses, has changed its firm name in order to correspond more closely with the name of its product. The company is now known as Willson Goggles Inc., which is the registered trademark of its product. The ownership and personnel of the company remains the same.

Edgar Allen & Co., Ltd., steel manufacturers of Sheffield, England, announce that the company has incorporated as an American concern under the name of Edgar Allen Steel Co., Inc., with headquarters at 718-722 W. Lake St., Chicago, Ill. The American company has the following officers: J. C. Ward, president; G. R. Bennett, vice-president and general manager; F. C. Leiferman, secretary and treasurer.

Doehler Die-Casting Co., Court and 9th Sts., Brooklyn, N. Y., at the annual meeting of the board of directors re-elected the following officers: H. H. Doehler, president; H. B. Griffin, vice-president; O. A. Schroeder, treasurer; and O. A. Lewis, assistant secretary. The list of officers was also added to as follows: J. Kranlund was made second vice-president in charge of production, and Charles Pack, secretary and chief chemist.

Frank H. Nickle, Saginaw, Mich., manufacturer of agitator driving yokes—a standard power transmission device for driving agitator or stirrer shafts in open or closed chemical tanks, kettles, and other containers, announces the organization of the Nickle Engineering Works with office and factory at 729 N. Niagara St., Saginaw, Mich. The company will install additional machine shop equipment and will increase its scope of operation.

International Oxygen Co., Newark, N. J., is establishing a new branch plant at Toledo, Ohio, to furnish oxygen and hydrogen for all purposes to the manufacturers and industries in that section, who use either one or both of these gases in their process. The capacity of the plant will be 3,000,000 cubic feet of gas per month. Over two hundred I. O. C. system oxygen-hydrogen generating plants are now in operation, both in the United States and abroad.

Fred C. Dickow, Chicago, Ill., manufacturer of the Dickow universal dividing head for milling machines, is erecting a new plant at 3504-3512 W. Lake St., Chicago. The building is a one-story brick construction, 77 by 100 feet, with a saw-tooth roof. It is expected that it will be ready for occupancy by March 1. A large increase has been made in the equipment, which will enable the company to handle its rapidly increasing business more effectively.

General Fire Extinguisher Co., Providence, R. I. announces that on January 1 all of the sales and contracting business that has for many years been carried on by the company, was taken over by a new company known as the Grinnell Co., Inc., with executive offices in Providence, R. I. The business which the Grinnell Co. takes over from the General Fire Extinguisher Co. relates to fire protection; power and process piping, steam, hot water, and gas heating; drying; and sales of pipe fittings, valves and supplies.

Fairbanks Co., 416 Broome St., New York City, announces that it has recently signed a contract with the Lincoln Electric Co., of Cleveland, Ohio, for the exclusive distribution of Lincoln electric motors for industrial applications. The line includes alternating-current motors for two-phase and three-phase circuits, from ½ to 500 horsepower, for all commercial voltages and frequencies, and direct-current motors from ½ to 150 horsepower. The Fairbanks Co. will cooperate with the various Lincoln district offices in connection with the sale of the manufacturer's other products.

Joseph T. Ryerson & Son, Chicago, Ill., announce that they have recently formed an association with the Conradson Machine Tool Co., of Green Bay, Wis., for the sale of Conradson machine tools. The line consists of plain and universal milling machines, selective-head lathes, planers, and radial drilling machines, which are being sold under the trade name of Ryerson-Conradson. The Conradson plant in Green Bay has recently been completed, equipment has been installed, and production is now under way.

Cambridge & Paul Instrument Co., Ltd. has been formed through the amalgamation of the business carried on by Robert W. Paul of New Southgate, London, England, and the Cambridge Scientific Instrument Co., Ltd., Cambridge, England. Mr. Paul will join the board of directors, and the manufacture of scientific instruments will be continued both at Cambridge and at New Southgate. It is believed that the experience gained by the staffs of both firms, when combined, will lead to greater and more rapid advances in the design and manufacture of scientific instruments.

Cutler-Hammer Mfg. Co., Milwaukee, Wis., has added to the space devoted to the industrial electric heating department. The industrial heating line, which is now being expanded, includes electric space heaters, electric soldering irons, linotype pot heaters, metal melting pots, immersion water heaters, circulation water heaters, and heater units for application to all types of machinery. The manufacture of household electric appliances, such as irons, toasters, etc., has been discontinued, and the space formerly devoted to that line has also been turned over to the industrial heating line.

Allen Spindle Corporation has been organized, with a capitalization of $55,000, by Elliott A. Allen, for the purpose of manufacturing ball-bearing textile spindles. Mr. Allen served for eight years as sales engineer of S. K. F. ball bearings and was recently New England district manager for the S. K. F. Industries. A modern spindle plant has been leased, and production is well under way. It is stated that additional machinery is being purchased and an extension of the plant is already anticipated. The headquarters of the Allen Spindle Corporation are in the Little Building, 80 Boylston St., Boston, Mass.

Service Engineering Co., 25 Church St., New York City, has been incorporated under the laws of the state of New York with a capital stock of $50,000, to render general engineering service and to specialize in the design of tools, jigs, fixtures, and methods for interchangeable manufacturing of motor cars, motor trucks, typewriters, adding machines, and other products made in quantities. The officers of the new company are Albert A. Dowd, president; Donald A. Baker, vice-president; Fred E. Rogers, treasurer; and Thomas P. Orchard, secretary. The company employs a force of about sixty men, and is prepared to give engineering service on short notice.

Vonnegut Machinery Co., 43 S. Meridian St., Indianapolis, Ind., has let contracts and started work on a building, 100 by 300 feet, with two stories and basement, of reinforced concrete and metal sash factory type construction, which will represent an investment of about $300,000. The location is at 19-29 W. South St., opposite the Union Station, Indianapolis. The first floor and basement will be used for the entire business, including office, display floor and storage for the machine tool and machinery accessories department, as well as machine shop and storage facilities for the used machinery department. The second floor will be available for rental purposes. Exceptionally heavy construction is employed with the idea of adding three or four additional stories in the future.

Electric Furnace Co., Alliance, Ohio, has made a number of installations of electric furnaces recently which are of interest on account of the new type of equipment involved and the special alloys which are to be melted. Among these may be mentioned the installation of a Baily electric furnace for melting yellow brass, in the shops of the Standard Sanitary Mfg. Co., Louisville, Ky.: a 105-kilowatt furnace for melting red and yellow brass in the works of the Akron Bronze & Aluminum Co., Akron, Ohio; a 500-pound furnace for melting gray iron in the plant of the Wasson Piston Ring Co., at Plainfield, N. J.; a 105-kilowatt nose-tilting furnace of one ton capacity, with a special motor-operated casting table so designed that metal may be poured directly into the molds, in the plant of Mitsui & Co., Japan.

F. J. Littell Machine Co., of Chicago, Ill. has been incorporated under the laws of Illinois with a capitalization of $35,000, and has taken over all the assets and liabilities of the Acme Machine Works 4125-4127 Ravenswood Ave., Chicago, Ill. The new company will continue the manufacture of roll feeds, dial feeds, and special feeds for punch presses. The officers are F. J. Littell, president and general manager; Edwin Swangren, vice-president and superintendent of shop; M. E. Wittich, treasurer; W. N. Stevenson, secretary, in charge of engineering department. The management remains the same with the exception that Edwin Swangren, who has been assistant superintendent of the American Can Co.'s Maywood machine shop for several years, will take charge of the manufacturing, as well as being vice-president. Additional capital is being added to take care of the increasing business of the company.

Wyman-Gordon Co., Worcester, Mass., manufacturer of forgings, announces that the company has consolidated with the Ingalls-Shepard Forging Co., of Harvey, Ill., the purpose of the consolidation being to improve the service to the customers of both companies. Plans are under way for increasing the capacity and efficiency of both plants and for specializing in forgings of importance in the automobile industry, such as crankshafts, camshafts, axles, gears, steering knuckles, etc. The Harvey, Ill. works will be known as the Ingalls-Shepard Division of the Wyman-Gordon Co. F. A. Ingalls, president of the Ingalls-Shepard Forging Co., will become a vice-president of the Wyman-Gordon Co., and will be in active charge of the Harvey works. The general offices of the company will continue to be located at Worcester, Mass., which will be the headquarters of George F. Fuller, president, and Harry G. Stoddard, vice-president and general manager.

Keuka Industries, Inc., Hammondsport, N. Y., announce that a new organization with that name has taken over the completely equipped motor factories of the Curtiss Aeroplane and Motor Corporation at Hammondsport, N. Y. The officers of the new company are L. J. Seely, president; John H. McNamara, vice-president; K. B. MacDonald, secretary and treasurer. The directors are Glen H. Curtiss, Hammondsport; K. B. MacDonald, Buffalo; J. H. McNamara, Hammondsport; Hugh Satterlee, New York; and L. J. Seely, Hammondsport. With the exception of Mr. Satterlee, all the directors are men who for years have been connected with the Curtiss Aeroplane & Motor companies. It is the object of the new company to develop a very high-grade automobile engine, it being believed that this will be possible because the organization includes the men who have in the past turned out one of the best known airplane motors in the country.

Norton Co., Worcester, Mass., announces that a Canadian company has been incorporated with a capital of $500,000 which will make grinding wheels for the Canadian market of the same kind and quality as those made at the Norton plant in Worcester. A plant is now being built at Hamilton, Ontario, of which the main building is in three stories, 50 by 100 feet, in addition to which there is a kiln building, 60 by 128 feet, two stories high, with provision for four kilns. It is expected that the Canadian company will employ 100 men at the start and that manufacturing operations will begin about April 1, after which Canadian orders will be filled directly from the Canadian plant. In order to insure the same quality of product as obtained in the Worcester plant, the superintendent and the foremen of the Canadian plant will be taken directly from the Norton plant in Worcester. Robert C. Douglas, who has been connected with the Norton Co. for many years and who has for years traveled in the Canadian territory, will be general manager of the plant.

A. L. Kirby Co., 828 Broad, St., Newark, N. J., opened offices on January 1 to engage in the sale of all kinds of sheet metal working machinery. A. L. Kirby of this firm was for the last thirteen years associated with the Loy & Nawrath Co., builder of draw-benches and sheet metal working equipments, and was vice-president and general manager of the company at the time of his resignation; he still retains the office of vice-president and continues as a member of the board of directors. A. J. Ellis who has been engaged in the manufacture of such sheet-metal articles as metal window frames, metal-covered doors, hollow steel doors, metal furniture, etc., is associated with Mr. Kirby in the A. L. Kirby Co. It is the purpose of the firm to give its customers specialized engineering service, a feature of which will be the development of sheet-metal products and the selection of equipment for use in manufacturing such products; also, the preparation of specifications for, and the supervision of the building and erection of the equipment. W. F. Burditt, Jr., formerly with the Loy & Nawrath Co., is chief engineer of the A. L. Kirby Co.